Gregg River Resources Ltd.

DEMONSTRATION AND EVALUATION OF AN INTEGRATED TRUCK MANAGEMENT SYSTEM IN A PRODUCING CANADIAN SURFACE COAL OR OIL SANDS MINE

Final Report

by

Gregg River Resources Ltd.
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EXECUTIVE SUMMARY

Since 1984 the CANMET, Surface Mining Laboratory, presently located in Devon, Alberta has investigated truck/shovel management systems applicable to surface coal mines in Western Canada. During these investigations, it became apparent that an integrated data collection and truck management system is needed to address the needs of the mining industry.

Several mining companies were interested in various data collection and truck management systems that may be used to collect reliable field data and use this information for optimization studies. It was expected that optimization studies of the mining operation will identify ways to improve mine production, reduce operating cost and improve efficiency. To achieve these objectives, the mine operator must fully utilize the existing fleet of mine equipment, eliminate non-productive times, have control over operation and above all must know how the equipment is performing at any given time. There are several highly sophisticated and reliable systems; such as electronic and computerized control of machinery, sensing of unit operations or totally integrated data collection and management systems.

During the course of the investigation, information on such data collection and management systems were collected and evaluated. The search was limited to systems that could be directly applied to the trucking operation at surface coal mines in Canada and restricted to on-board systems.

Industry interest in this review of onboard truck management systems led to a cooperative demonstration and evaluation project of an integrated control system on two Euclid R-170 trucks at the Gregg River mine near Hinton, Alberta. This installation was preceded by review of all existing data acquisition systems. After evaluation, the Onboard Data Acquisition System (OBDAS) developed by Philippi-Hagenbuch, Inc. of Peoria, Illinois, was selected for field trial.

The OBDAS system was tested at Gregg River mine from January to November, 1987. The evaluation of system installation, performance, and reliability is discussed in the presented REPORT.

EVALUÀTION D'EXECUTIVE

Depuis 1984 le CANMET, L'aboratoire d'exploitàtion en surface présentement localisé à Devon, Alberta, firen' des recherches sur des systèmes de maniement de camions et de pelles applicable dans les mines de charbon à ciel ouvert de l'ouest canadien.

Plusieurs compagnies minières étaien' intéressées dans la cueillette de donnees variees et dans les systemes de maniement de camions, dont les données fiables et pratiques pourraient être rassemblées et utilisées à maximiser les études. Il était prévu que ces études, sur l'operation de mine, apporteraient des voies sur l'augmentation de production des mines, réduction des coûts d'opération et augmentation de l'efficacité. Pour arriver à ces objectifs, l'operateur de mine doit, utiliser au maximum sa flotte d'équipements existants, réduire les temps non productifs, avoir un contrôle sur l'opération et surtout il doit savoir comment ses équipements se comportent en tout temps. Il y a plusiers systèmes fiables et hautement sophistiqués, tel que des circuits électroniques et ordinateurs de contrôle de machineries qui surveillents les opérations d'un équipement ou de l'ensemble des équipements, et des données totalement intégrées dans le système de maniement de camions.

Pendant les études préliminaires, les informations sur les cueillettes des données et les systèmes de maniement furent assemblés et évalués L'étude s'est limitée, aux systèmes qui pourraient directement être utilisés a l'opération de camions pour mines de charbon à ciel ouvert au Canada et limitée aux systèmes à bord du camion.

L'intérêt de l'industriel pour les systèmes de maniement de camions a bord à conduit à une démonstration coopérative et à un projet d'évaluation d'un système de contrôle intégré sur deux camions Euclid R-170 à Gregg River Mine, Hinton, Alberta. Après l'évaluation de toutes les données et des systèmes existants. Le système de maniement de camions à bord developpé par Philippe-Hagenbuch Inc. de Peoria, Illinois fut choisi pour essai.

Le systeme de maniement de camions à bord fut mis à l'essai à Gregg River Mine entre Janvier 1987 a Novembre 1987. L'évaluation de ce système, sa performance et sa fiabilité seront discutées dans ce présent papier.

CONTENTS

	Page
Executive Summary	1
Evaluation D'Executive	ii
Contents	iii
Description of System Components	1
Installation and Performance	4
Data Collection and Processing	6
Output Evaluation	9
Conclusions	12

Tables

NO.:		
1.	Summary of Weight Studies	9
2.	Haul Cycle Time Studies	10

Diagrams

NO.:		
1.	Schematic of OBDAS (Input and Output to the Processing Unit)	13
2.	Load Sensor Assembly	14
3.	Fore-Aft Imbalance & Load Indicator Lights	15

Figures

NO.:		Page
1	OBDAS Raw Data	16
2	OBDAS Material Movement Report	17
3	OBDAS Production Report	18
4	OBDAS Utilization/Productivity Report	17
5	History of Truck Productivity (BCM/trip)	20

Photographs

List of Photographs 21

Appendices

List of Appendices 30

DESCRIPTION OF SYSTEM COMPONENTS

Central to the OBDAS system is an on-board microprocessor, used to manipulate input signals and provide output essential for equipment performance monitoring. The processing unit used by the system is a Motorolla 68HC11, capable of receiving both digital and analogue input signals and time relating these signals using a built-in clock. Presently eight digital and eight analogue signals are being sent to the processor, with capacity to handle 24 more of each type of signal. (Schematic of system illustrated on Diagram 1.)

OBDAS's primary on-board sensing function is weight or payload monitoring. It is through this function that the most direct benefit, through cost savings, can be realized by a mining operation. The OBDAS weighing system (described for Euclid R-170 trucks) features four load sensors installed on the truck frame and forming the contact area for the box rails. Each load sensor consists of a 9" wide by 79" (front) or 83" (back) long urethane jacketed flexible hose that is partially filled with oil. Each hose sits in a base plate channel assembly that has been mounted directly onto the truck frame. The ends of the hose are sealed shut with a clamp, with one end having a fitting for a 1/4" diameter nylon hose that leads to a pressure transducer. The presssure transducers, one for each load sensor, are mounted outside the cab of the truck and provide a voltage signal (varying with pressure) to the microprocessor. A floating cap channel with an inside contact plate having a specific area sits on top of the hose assembly. By applying the area of the contact plate to the pressure created in the hose by the truck's load, the weight being carried is produced. (Schematic of load sensor assembly illustrated on Diagram 2.)

In addition OBDAS collects the information required to complete a time study of each haul cycle; including times for loading, travel full, dumping, travel empty, and waiting. This is achieved by combining the built-in clock feature of the processor with input signals received from additional OBDAS hardware.

Travel/non-travel time and direction of travel are gained using a transmission directional (forward-neutral-reverse) switch. The reverse signal is picked up by using the truck back up alarm power signal, the neutral signal from

the truck neutral safety switch power signal and forward when there is no reverse or neutral signal.

The start/end point of the haul cycle is picked up from the dump switch; a mercury activated switch mounted near the pivot point of the dump body. An input signal is received from this switch when the truck box is raised for dumping, indicating completion of a haul cycle.

Travel distance is determined by a proximity switch which serves as an odometer by sending a signal to the processor at each complete tire revolution. The proximity switch is mounted on the left front wheel of the truck and consists of a sensing oscillator, a solid state amplifier and a switching device. Proximity switching is achieved when a metallic object (target) passes through the sensing field, representing one tire revolution. This changes the internal impedance of the oscillator, giving a signal to the microprocessor. By applying tire circumference to the number of revolutions (sum of signals received from the proximity switch), the distance travelled in each gear direction is determined.

To have the information required for a complete analysis of a haul segment the hardware installation includes an inclinometer for developing haul road profiles. A varying voltage signal, based on the slope the truck is on, is sent to the microprocessor from the level indicator. The inclinometer must be activated through the processor to receive output (slope indication is not monitored continuously); with output provided at every one degree change in road grade.

The remaining input to the microprocessor is entered by the truck operator through the processor key pad. This input includes an operator code number (corresponding to the employee number) and a combination code for the loading unit and dump destination that the truck is assigned to. The operator code (3-digit number) is entered at the start of the shift or when there is a change of operator on the truck. The loader/destination code is changed whenever there is a change to these assignments; and is replaced with an operating delay or maintenance code when the truck goes out of production. Through this coding, the ability to report productivity on an hourly basis and equipment utilization is achieved. (Description of the OBDAS coding established is given in Appendix A.)

Manipulation of the incoming signals and information output by the OBDAS microprocessor has been developed to provide real time monitoring onboard the truck and to remote locations.

Output signals for on-board viewing include a LED display on the front of the processing unit that provides a readout to the truck operator of actual load weight (tons). Through the key pad the date, time and a check for coding (operator, loader/destination) can also be displayed.

To give the loader operator an indication of load status a series of loading lights and imbalance lights are mounted on the truck (both sides). The loading lights consists of five lights; a green light indicating one or more bucket passes required, three amber lights indicating portions of a bucket required, and a red light indicating that the rated payload has been reached. The fore-to-aft imbalance lights give an indication to the loader operator if the next bucket should be placed towards the front or back of the truck to achieve a balanced load.
(Schematic of lights illustrated on Diagram 3.)

Additional onboard output includes a printer that is used as backup for data collection, gathering road profile information when required, and running diagnostic checks on the system.

Real time remote monitoring is achieved through a radio frequency (RF) data link (built into the processor) to the VAX 11/750 computer located in the engineering/administration office: 300m to 3000m away from the truck operating location.

Input signals to the microprocessor are compiled and output, either to internal storage or to RF transmission, whenever there is a change in the truck transmission position as signalled by the forward-neutral-reverse directional switch. The line of data compiled at this point, as illustrated in Figure 1, includes truck number, clock time, load weight in tons, transmission position, length of time spent in this position, and distance travelled in this position. The dump signal indicates the end of the haul cycle, with the raw data output at this time indicating cumulative time and travel distance since the last dump signal was received.

INSTALLATION AND PERFORMANCE

OBDAS was installed on two, from a present fleet of eight, Euclid R-170 haul trucks being used primarily for waste rock haulage at the Gregg River Mine near Hinton, Alberta, Canada.

Initial installation of the system hardware was done by Philippi-Hagenbuch field personnel and minesite maintenance employees in January, 1987. Approximately four days per truck were required for the installation with the major delay being modifications required to the load sensor base plate assembly. These modifications required changes to the base plate-to-truck frame bolt positions to get around the fuel and hydraulic oil tanks that are also mounted to the truck frame.

Concurrent with the installation, orientation discussions were held with the truck drivers and pit foremen to familiarize them with the project and operation of the system and to start receiving their feedback on the system. From this feedback minor changes were made, aimed at making the system less distractive during night time operation. These included dimming the LED display and setting the loading lights so they only come on when the truck is in neutral; eliminating glare and mirror reflection when backing up to spot at the loader and dump.

As part of the evaluation process the mechanical reliability of the system with time and any subsequent effect on truck mechanical availability and operator acceptance was closely monitored.

The main source of OBDAS downtime during the evaluation period was the load sensor assemblies. During the latter part of Janaury the load sensor hoses started leaking oil at the end clamps on both trucks. Further investigations also found that the hoses were being cut by the cap channel contact plate when oil level became low. A review of these problems by Philippi-Hagenbuch concluded that steel rather than aluminum clamps were required to form a seal at the hose ends and that the contact plate would have to be machined to a narrower width (1/8") to prevent the cutting problem. Because of the time required to manufacture new clamps, the load sensor assemblies were not repaired until mid March. Approximately three days per truck were required to implement these repairs.

Oil leaking at the load sensor hose clamps was evident within three weeks of the March repairs. At this time it was noticed that torque on the hose clamp bolts could not be maintained; indicating that the hose was stretching or creeping under the pressure exerted by the clamps. Temperature readings were also taken on the load sensor hoses to determine if nearby exhaust ducting might play a role in the hose stretching. Although temperature was not considered a factor, it was determined that the material properties of the hose were at fault. As a result of production interruptions at the mine combined with the time required to manufacture and test new hose, these corrections were not completed until the end of August. Truck down time to make these repairs was reduced to less than 24 hours per unit. At the time of writing of this report, no further problems have been experienced with the load sensors, representing a four month trouble free period.

Although other minor problems have occurred with the system hardware, their effect on system reliability was that of losing output data versus losing truck production time. These include repairs/replacements to dump and proximity switches and problems related to radio communications.

DATA COLLECTION AND PROCESSING

The data collection software was programmed in FORTRAN on the VAX 11/750 minicomputer and acts as an interface between the OBDAS radio download system and the data storage and reporting system on the VAX. (Printout of program is enclosed in Appendix B.)

The OBDAS radio download system consists of a radio frequency (RF) modem within the processor box, a GE portable FM (UHF) radio connected to a low profile colinear antenna (5 Db gain) on the truck cab, a UHF yaggie antenna (10 DB gain) on top of the 60 metre high coal storage silos, another identical radio, a Telxon 202 RF modem, two line drivers connected to each end of a four pair telephone circuit, and finally the RS232 connection to the terminal multiplexor on the VAX. The base station (antenna, radio, RF modem, and one line driver) is situated on top of the silos in a NEMA enclosure using a simple thermostat and light bulb for heat. The line drivers amplify the receive and transmit signals only. The other lines (signal ground, data terminal ready - DTR, and carrier detect) are connected directly, via the telephone cable, from RF modem to VAX multiplexor. Although DTR is mentioned as one of the operational lines, this actually controls the request to send (RTS) signal within the RF modem by jumpering. This was due simply to the lack of software control of RTS within the VAX. Therefore, in that which follows the references to RTS actually means DTR on the VAX which is jumpered to RTS on the modem.

The simplified sequence of steps for data collection is as follows:

- bring up RTS
- wait 40 msec.
- send out a poll sequence containing the truck number
- wait 200 msec.
- turn off RTS
- get ready to accept data
- if no data is received in 2 seconds, go back to beginning and poll the next truck
- if data is received, verify it using a checksum and if not okay, go back and repoll the same truck

- if data is okay, store it, while still receiving
- if data is not received again within 2 seconds, then send an okay to the truck and go back to poll the next truck

The data sent from the OBDAS processor (duplicated on the printer when turned on) has a maximum of 40 characters per record, with a checksum and truck number. The latter information was added to the software after it was found that errors were occurring in the data, especially during high winds. Errors were reduced substantially during calm weather and snow conditions, but as no errors were acceptable, the checksum method of error-checking was implemented.

The data collection software is submitted in batch with a higher priority than other users and is automatically initiated on re-boot of the system. The various options (such as baudrate, parity, etc.) on the VAX multiplexor port are software selectable. The system is currently operating at 1200 baud. Initially there was a problem with RTS hanging constantly high after about eight hours of operation. The port settings were changed to disable the use of XOFF/XON and to increase the type ahead buffer and no problems have been encountered since.

As well as polling and repolling for data, and sending an okay, the same method can be used to change OBDAS date and time, check to see if a unit is operational, and to send a four digit message to the remote processor's display. The latter could be useful to indicate which shovel and/or dump the truck operator should go to, assuming a dispatching system.

To avoid loss of data in the event of a VAX disk failure, the OBDAS data is stored on two different disks at the same time. If the computer goes down for maintenance, power outages, etc., the OBDAS processor can store up to four hours of data which will be sent in a stream once the computer comes back up and another poll sent out.

As seen in Figure 1, the raw OBDAS data is quite wordy and descriptive. This is useful on the printer output but very inefficient for storage and retrieval of information for analysis and reporting. Therefore, a data base was created consisting of six files:

1. Gear Changes - key info for cycles, times and tonnages.
2. Shovel Changes - not only shovel info but also dump locations, down time, and maintnenance reasons.
3. Operator Changes - times of operator changes, average loads, and tonnages.
4. Truck Off - tells when truck or OBDAS is turned off.
5. Inclinometer Readings - when this option is turned on the data goes here.
6. Test Data - records all test info when the test key is pushed - about 80 lines of data.

These files contain all of the data in a much more efficient format. For example, the seven lines (200 characters) of a shovel change are condensed into a single 38 character record. This reduces both disk space and CPU and I/O in accessing the information. All data is stored in indexed sequential files with the real time date and time used as they key. Raw data is run through an editing routine before being stored in the data base. This allows data which does not conform to standard formats, or seems out of sequence, to be edited on the CRT screen, along with the most likely format for comparison. Before the use of checksums the editing procedure was very time consuming. Currently, errors average about one per shift per truck.

The first step in analysing the OBDAS data is to resolve the haul cycles. Since signposts are not used to locate the trucks, the haul full and haul empty portions of the cycle can be determined by the load tonnage. Thus when the load sensor system was inoperable for extended periods, cycles could not be resolved. All of the portions of a cycle, and the time spent, can be determined by the current, previous, and following gear, time, and tonnage. The DUMP record is also important in resolving cycles, and total time (dump to dump) on the record is used as a check on the total gear change times. However, this record does not give the most accurate tonnage for the haul cycle. Also, because the trucks are being loaded as they are spotting (in reverse) to load, and starting to haul (in forward), the tonnage in neutral (loading) is also not the most accurate. It has been verified using truck scales that the most accurate tonnage is the average generated during the haul, loaded.

OUTPUT EVALUATION

As part of the OBDAS evaluation, a series of studies were carried out to confirm the accuracy of the systems output and repeatability of the output over time. These studies included a series of independent weigh studies and time studies and a review of historic truck performance versus performance after the OBDAS installation.

The weigh studies were carried out to check the accuracy of the load sensors; advertised at +/- 2%, and the overall impact on average fleet payload. Table 1 summarizes the results (in tons) of the three weigh studies carried out in conjunction with the OBDAS evaluation. The initial study was done prior to installation of the system (November, 1986) followed by a study in January, shortly after initial installation (prior to fixing the load sensors) and a study in September after completing load sensor repairs. (Details of the individual weigh studies are presented in Appendix C.)

Although it is evident that the scaled figures reflect errors as a result of scale accuracy and/or calibration, as indicated by the variance in NVW from each study, the trends indicated by the results are valid. From the January and September studies, the scaled results indicate that the trucks equipped with OBDAS were hauling 6.1 and 5.9 ton more than the trucks without OBDAS. Comparing the separate weights obtained for the two trucks equipped with OBDAS (OBDAS vs. average of scales + OBDAS) variances of +2.4% and +1.9% are calculated.

TABLE 1 - SUMMARY OF WEIGH STUDIES (tons)

	November 1986	January 1987	September 1987
Number of Scaled Loads	128	139	82
Average NVW	120.9	127.3	135.8
Scaled Weights:			
Fleet Average	132.6	140.1	169.1
Trucks without OBDAS	132.6	137.8	166.5
Trucks with OBDAS	-	143.9	172.4
OBDAS Weights:			
2 truck average	-	150.9	179.1

To confirm the payload increases indicated by the weigh studies a review of actual truck production for the year prior to installing OBDAS and since installing OBDAS was completed. Using surveyed waste production figures, measured in bank cubic metres (BCM) and a count of truck loads from daily time card data, a figure for BCM per load or trip is obtained. In 1986 the fleet of R-170 haul trucks averaged 55.3 BCM per trip, or 154.8 ton using a specific gravity of 2.54. In the eleven month period following the installation of OBDAS on two trucks, the fleet (8-trucks) has averaged 57.3 BCM per trip, or 160.4 ton. (Refer to Figure 5.)

To evaluate the time dependent information that OBDAS produces, and the breakdown of this information into haul cycle components (load, travel full, dump, travel empty, etc.) a series of coincidental time studies were performed for comparison. Table 2 summarizes two examples from the results of these comparisons along with the truck travel times arrived at using the minesite simulation program (based on rimpull curves). These results indicate a close correlation between OBDAS and the manual time studies for all components of the haul cycle. The variances that do occur are largely the result of instances when the truck operator decides to change gears (OBDAS transmission/direction signal) when waiting, spotting and pulling away from the loader or dump. (Details of the time studies are enclosed as Appendix D.)

TABLE 2 - HAUL CYCLE TIME STUDIES (min:sec)

	TRUCK CYCLE ANALYSIS #1			TRUCK CYCLE ANALYSIS #2		
	OBDAS	MANUAL STUDY	COMPUTER SIMULATION	OBDAS	MANUAL STUDY	COMPUTER SIMULATION
Travel Empty	4:22	3:59	3:50	4:26	4:23	4:51
Wait at Shovel	0:03	0:04		1:10	1:37	
Spot at Shovel	0:27	0:27		0:33	0:21	
Loading Time	1:22	1:47		1:40	1:50	
Travel Full	6:27	6:31	6:25	6:30	6:30	7:07
Wait at Dump	1:42	1:44		2:03	2:10	
Spot at Dump	0:44	0:42		0:22	0:19	
TOTAL CYCLE TIME	15:41	16:07		17:28	17:53	

To demonstrate the use of OBDAS as a means to compile truck production statistics a group of three reports were designed for output at any given time interval (shift, daily, weekly, etc.). Examples of these reports are shown as Figures 2, 3, and 4. These reports utilize the output generated by OBDAS along with the data presently compiled at the mine to track daily equipment performance and production.

The OBDAS material movement report, Figure 2, provides a summary by truck for each loader/destination assignment of total quantity moved and average load. Based on the number of truck cycles that can be resolved (computer picks up all the proper, transmission/direction signals to put a haul cycle together) a cycle time analysis for each loader/destination assignment is also reported.

The OBDAS production report, Figure 3, summarizes truck production for each loader assignment by material type. If OBDAS were expanded to include all haulage units, a report of this nature would provide total mine production, with the possibility of replacing surveys to generate production volumes.

The OBDAS utilization/productivity report uses the codes designating "operating delay and maintenance downtime" (entered through the process key pad) to generate a complete breakdown of time utilization through a shift (or other designated interval). Mechanical availability and utilization factor (measures effective use of mechanically available time) is also reported along with the trucks' production on an hourly basis. Extended over a period of time this report could be used by maintenance planning to track specific downtime and repair time.

CONCLUSIONS

Applying the truck productivity increases realized with the installation of OBDAS, as shown by the increase in average load per cycle from 55.3 to 57.3 BCM, to Gregg River's present waste haulage cost indicates that a savings of $0.02 per BCM has been achieved. At the present annual waste capacity of 12 million BCM this represents savings of $240,000; easily justifying the capital expenditure of $60,000 for system hardware (to fit two trucks plus radio communications). Because the weigh studies indicate that the two trucks having OBDAS are carrying a greater payload than trucks without OBDAS, expanding the system to cover the entire fleet should further increase savings. Providing the system proves to be dependable, in particular the load sensor assemblies, OBDAS can provide productivity and cost improvements to the mines haulage function.

In addition to providing measurable production improvements, OBDAS also demonstrated the ability to develop the information base and real time monitoring needed to develop a dispatching system. The microprocessor is also able to accept additional input, that could increase its use as a maintenance monitoring and planning tool.

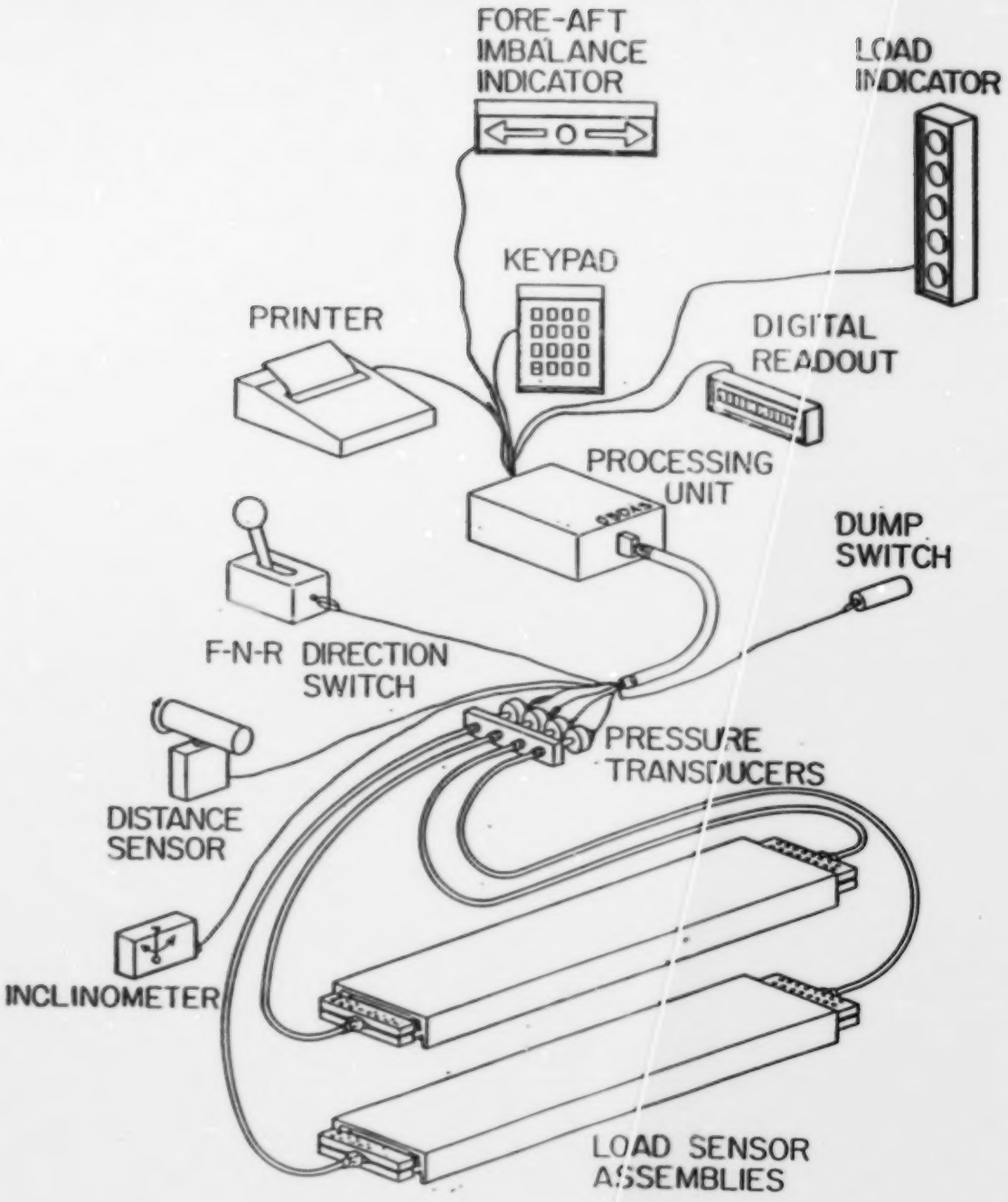


Diagram 1: Schematic of OBDAS (Input and output to the processing unit)

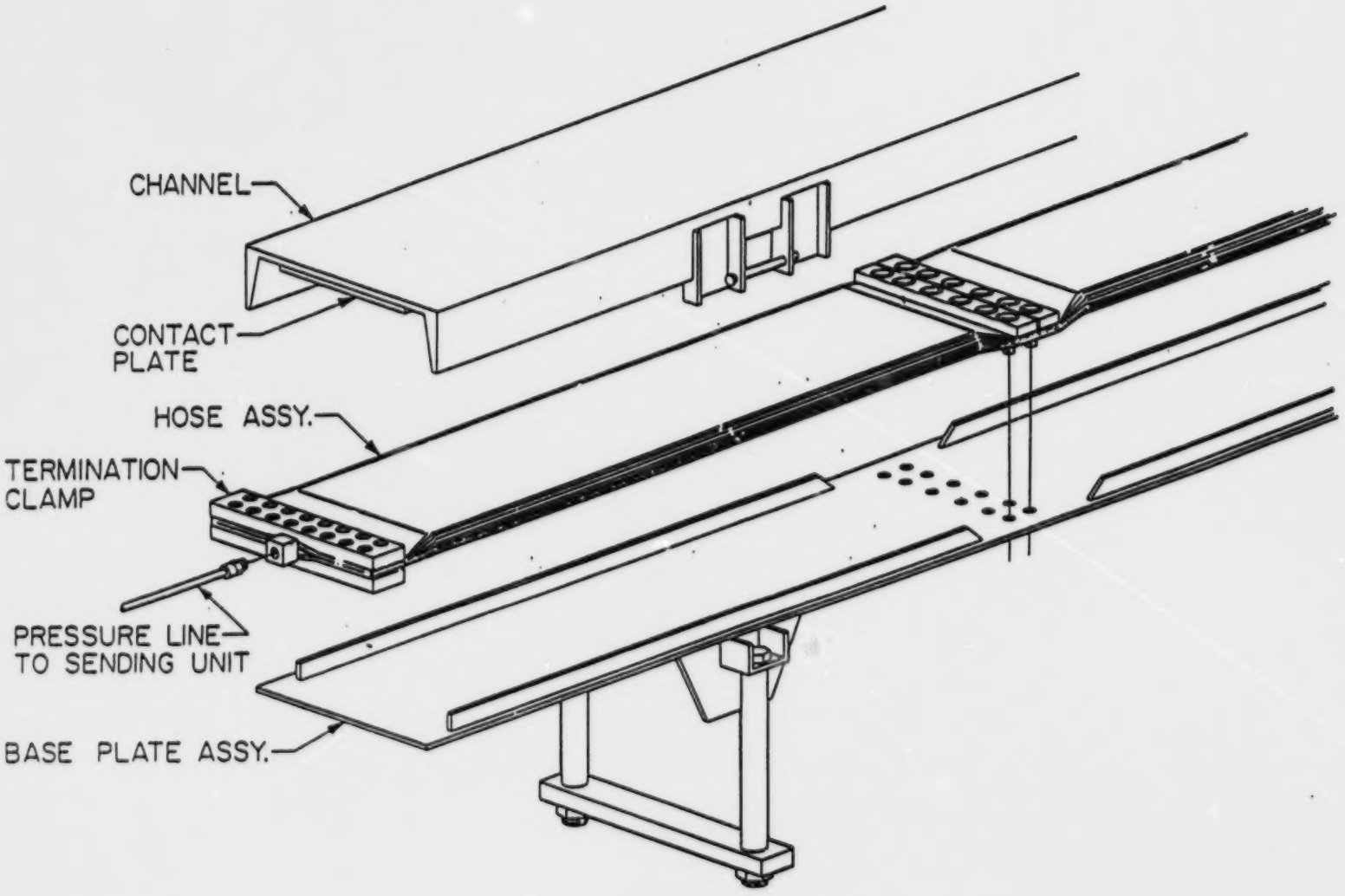


Diagram 2: Load Sensor Assembly

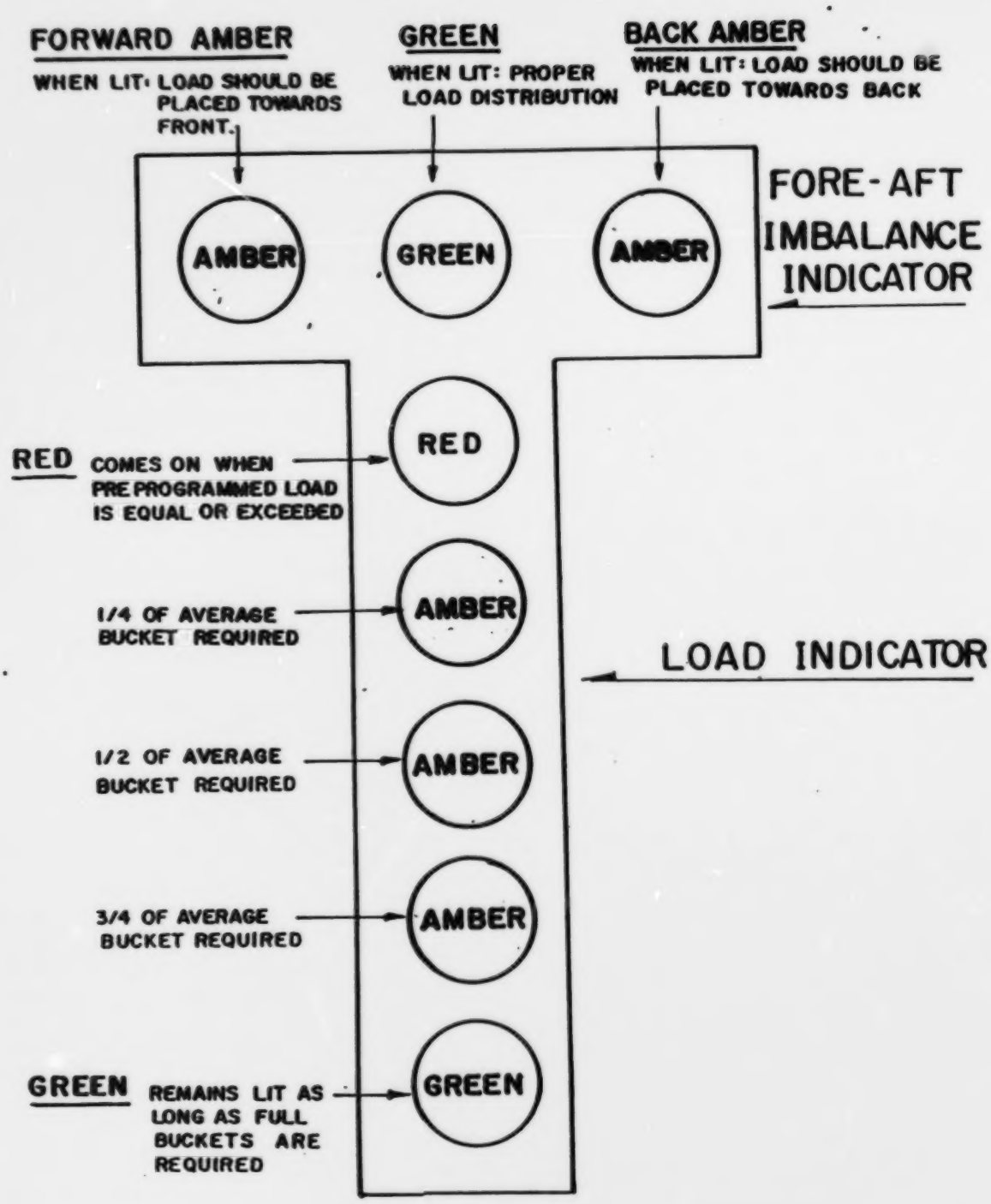


Diagram 3: Fore-Aft Imbalance and Load Indicator Lights

```
TRUCK #26  OBDAS 6811 VER 787 PAD SQ.IN.   2712
TRUCK #26 TRUCK LAST RUN 10/01/87 11:10:05
TRUCK #26 TRUCK STARTED 10/01/87 11:10:11
TRUCK #26 TRUCK NUMBER   0026
TRUCK #26 OPERATOR NUMBER 000259
TRUCK #26 SHOVEL NUMBER 000305
TRUCK #26  OBDAS 6811 VER 787 PAD SQ.IN.   2712
TRUCK #26 TRUCK LAST RUN 10/01/87 11:10:17
TRUCK #26 TRUCK STARTED 10/01/87 11:16:46
TRUCK #26 TRUCK NUMBER   0026
TRUCK #26 OPERATOR NUMBER 000259
TRUCK #26 SHOVEL NUMBER 000305
TRUCK #26 11:17 000 TON NEUT 00 MIN 33 SEC 00.0M
TRUCK #26 11:21 000 TON FORW 04 MIN 39 SEC 01.5M
TRUCK #26 11:22 000 TON NEUT 00 MIN 20 SEC 00.0M
TRUCK #26 11:22 001 TON FORW 00 MIN 27 SEC 00.1M
TRUCK #26 11:23 034 TON REVR 00 MIN 25 SEC 00.0M
TRUCK #26 11:24 181 TON NEUT 01 MIN 35 SEC 00.0M
TRUCK #26 11:34 174 TON FORW 09 MIN 52 SEC 02.5M
TRUCK #26 11:35 141 TON REVR 00 MIN 25 SEC 00.0M
TRUCK #26 11:35 176 TON DUMP 18 MIN 44 SEC 04.1M
TRUCK #26 11:35 000 TON NEUT 00 MIN 36 SEC 00.0M
TRUCK #26 11:39 000 TON FORW 03 MIN 44 SEC 01.2M
TRUCK #26 11:39 000 TON REVR 00 MIN 05 SEC 00.0M
TRUCK #26 11:39 000 TON FORW 00 MIN 11 SEC 00.0M
TRUCK #26 11:40 000 TON NEUT 00 MIN 42 SEC 00.0M
TRUCK #26 11:40 000 TON REVR 00 MIN 22 SEC 00.0M
TRUCK #26 11:44 000 TON FORW 03 MIN 50 SEC 01.5M
TRUCK #26 11:44 033 TON REVR 00 MIN 26 SEC 00.0M
TRUCK #26 11:46 191 TON NEUT 01 MIN 24 SEC 00.0M
TRUCK #26 11:57 189 TON FORW 11 MIN 05 SEC 02.6M
TRUCK #26 11:57 162 TON REVR 00 MIN 19 SEC 00.0M
TRUCK #26 11:58 187 TON DUMP 22 MIN 47 SEC 05.4M
TRUCK #26 11:58 000 TON NEUT 00 MIN 34 SEC 00.0M
TRUCK #26 12:05 000 TON FORW 07 MIN 11 SEC 02.5M
TRUCK #26 12:05 032 TON REVR 00 MIN 21 SEC 00.0M
TRUCK #26 12:07 162 TON NEUT 01 MIN 26 SEC 00.0M
TRUCK #26 12:17 162 TON FORW 10 MIN 10 SEC 02.5M
TRUCK #26 12:26 000 TON FORW 07 MIN 59 SEC 02.5M
TRUCK #26 12:26 047 TON REVR 00 MIN 27 SEC 00.0M
TRUCK #26 12:27 102 TON NEUT 00 MIN 51 SEC 00.0M
```

Figure 1: OBDAS Raw Data

1. OBDAS MATERIAL MOVEMENT REPORT:

DATE/TIME: 87/10/01 07:00 TO 87/10/01 19:00
CREW: B SHIFT: Day FOREMAN:J. Vinkle
TRUCK NUMBER: 6126

OPERATORS: 259

Loader Assignment		6003
Location		PQ1 1668 006
Dump		D5
Material:	Type	Waste
	Tonnes	4140
	# Loads	24
	Ave. Load	172.5
Truck Cycle Analysis:		# Resolved Cycles = 24
(Decimal Minutes)		Average Total
	Travel Empty	7.74 185.67
	Wait@ Shovel	1.93 46.27
	Spot@ Shovel	0.60 14.47
	Loading Time	1.75 42.03
	Travel Full	10.62 254.87
	Wait @ Dump	0.17 4.12
	Spot @ Dump	0.49 11.65
	Dump Time	0.61 14.58
Average Total Cycle Time		23.90
Average Cycle Distance(K)		5.2
Average Travel Speed		16.94
Average Speed Loaded		14.64
Average Speed Empty		20.10
Average Cycle Speed (Kph)		13.01
Fuel Consumption		N/A

Figure 2: OBDAS Material Movement Report

2. OBDAS PRODUCTION REPORT:

DATE/TIME: 87/10/01 07:00 TO 87/10/01 19:00
CREW: B SHIFT: Day FOREMAN:J. Vinkle

TRUCK:	6126			6127		
LOADER	WASTE	COAL	TOPSOIL	WASTE	COAL	TOPSOIL
6001:Tonne	0	0	0	0	0	0
#Loads	0	0	0	0	0	0
Ave.Load	0.0	0.0	0.0	0.0	0.0	0.0
6002:Tonne	0	0	0	0	0	0
#Loads	0	0	0	0	0	0
Ave.Load	0.0	0.0	0.0	0.0	0.0	0.0
6003:Tonne	4140	0	0	4693	0	0
#Loads	24	0	0	28	0	0
Ave.Load	172.5	0.0	0.0	167.6	0.0	0.0
6021:Tonne	0	0	0	0	0	0
#Loads	0	0	0	0	0	0
Ave.Load	0.0	0.0	0.0	0.0	0.0	0.0
6022:Tonne	0	0	0	0	0	0
#Loads	0	0	0	0	0	0
Ave.Load	0.0	0.0	0.0	0.0	0.0	0.0
6031:Tonne	0	0	0	0	0	0
#Loads	0	0	0	0	0	0
Ave.Load	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL:Tonne	4140	0	0	4693	0	0
#Loads	24	0	0	28	0	0
Ave.Load	172.5	0.0	0.0	167.6	0.0	0.0
	BCM	Tonnes	BCM	BCM	Tonnes	BCM
TOTAL:Payl.	1630	0	0	1848	0	0
#Loads	24	0	0	28	0	0
Ave.Load	67.9	0.0	0.0	66.0	0.0	0.0

Figure 3: OBDAS Production Report

3. OBDAS UTILIZATION/PRODUCTIVITY REPORT:

DATE/TIME: 87/10/01 07:00 TO 87/10/01 19:00
CREW: B SHIFT: Day FOREMAN:J. Vinkle

TRUCK: / All Times In Hours	6126	6127
OPERATING DELAYS:		
Weather (801)	0.00	0.00
Blasting (802)	0.00	0.00
Eq. Moves (803)	0.00	0.00
Waiting (804)	0.00	0.00
Power (805)	0.00	0.00
Sub-Total:	0.00	0.00
FIXED DELAYS:		
Shift Start	0.00	0.00
Lunch/Rest Breaks	1.24	1.23
Servicing (806)	0.00	0.00
Shift End	0.00	0.00
Sub-Total:	1.24	1.23
MAINTENANCE DOWN TIME:		
Down-Travl (807)	0.00	0.00
Down-Wait (808)	0.00	0.00
Sub-Total:	0.00	0.00
NET OPERATING HOURS:		
Waste	10.76	10.77
Coal	0.00	0.00
Topsoil	0.00	0.00
Sub-Total:	10.76	10.77
TOTAL SHIFT HOURS:	12.00	12.00
PRODUCTIVITIES:		
Waste (BCM/NOH)	151.47	171.62
Coal (Tonne/NOH)	0.00	0.00
Topsoil (BCM/NOH)	0.00	0.00
Mechanical Availability	100.00	100.00
Utilization Factor	89.68	89.73
Effective Utilization	89.68	89.73

Figure 4: OBDAS Utilization/Productivity Report

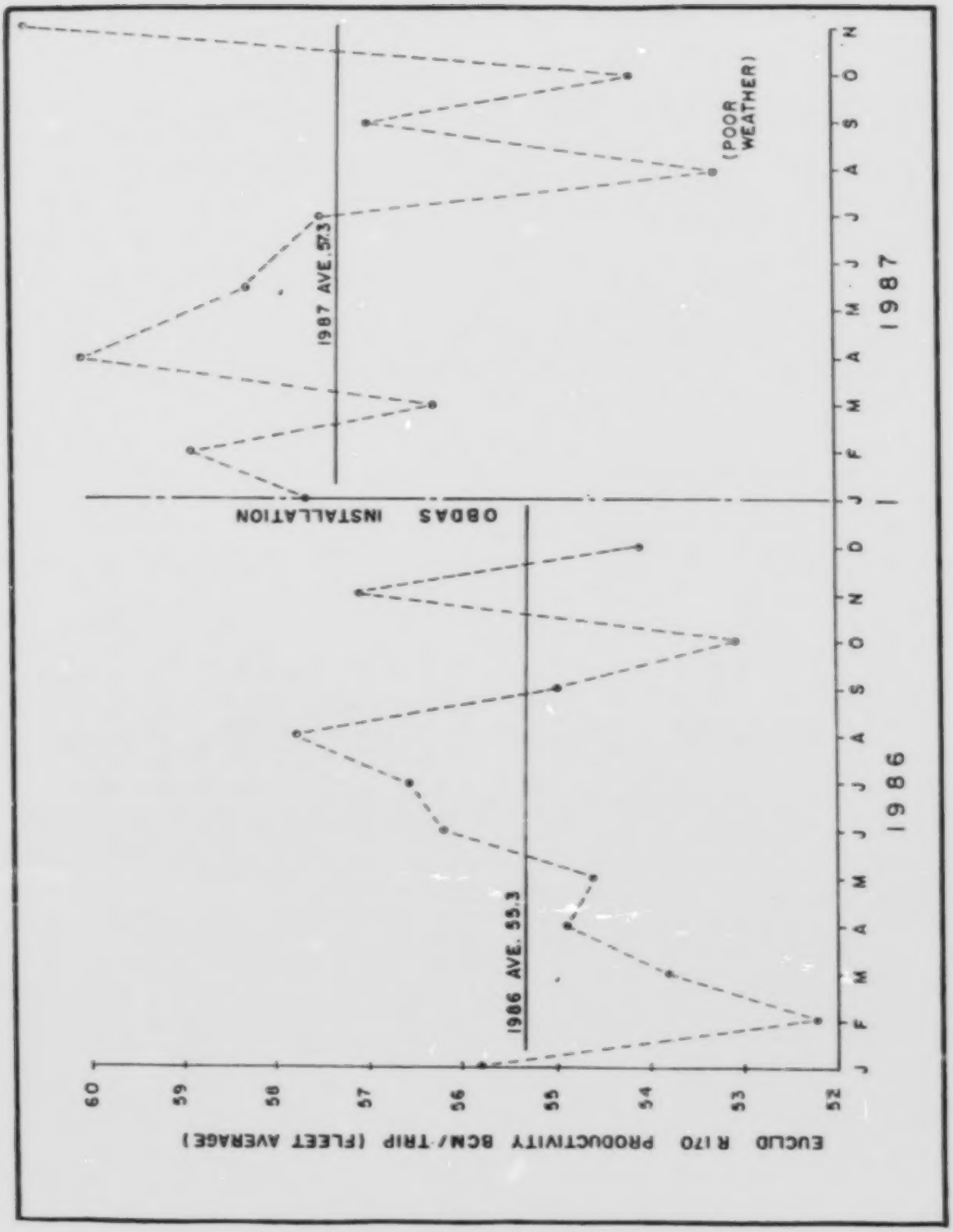


Figure 5: History of Truck Productivity (BCM/trip)

LIST OF PHOTOGRAPHS

PHOTO #1: View of Euclid R-170 haul truck (with box in dump position) indicating mounting location of OBDAS load sensors on the truck frame and box railings that will contact the load sensors when the box is lowered.

PHOTO #2: Close-up view of load sensor assemblies (4) and their location on truck frame in relation to hydraulic oil tank and dump cylinders.

PHOTO #3: Base plate assembly of load sensor (note location of exhaust ducting).

PHOTO #4: View of load sensor; urethane jacketed hose partially filled with oil and set into base plate channel.

PHOTO #5: Cap channel (with contact plate) placed over load sensor hose.

PHOTO #6: View of four complete load sensor assemblies.

PHOTO #7 and #8: View of clamps used to seal the ends of the load sensor hoses. Upper clamp on photo #7 is referred to as the transducer clamp, with fitting for a 1/4" nylon tube that leads to a pressure transducer. The lower clamp (photo #7) is referred to as the termination clamp.

PHOTO #9
and #10: View of the mounting locations and output example for the load sensor lights.

PHOTO #11: Pressure transducers (4) mounted outside the truck cab; showing 1/4" nylon tubing from load sensors at the base and lead wires (output voltage signals) to the processing unit.

PHOTO #12: View of proximity switch mounted at the left front wheel of the truck.

PHOTO #13: Indicates location of the dump switch; mounted behind the box hinge pin.

PHOTO #14: View of microprocessor, key pad with LED display and data transmission radio mounted in the truck cab.

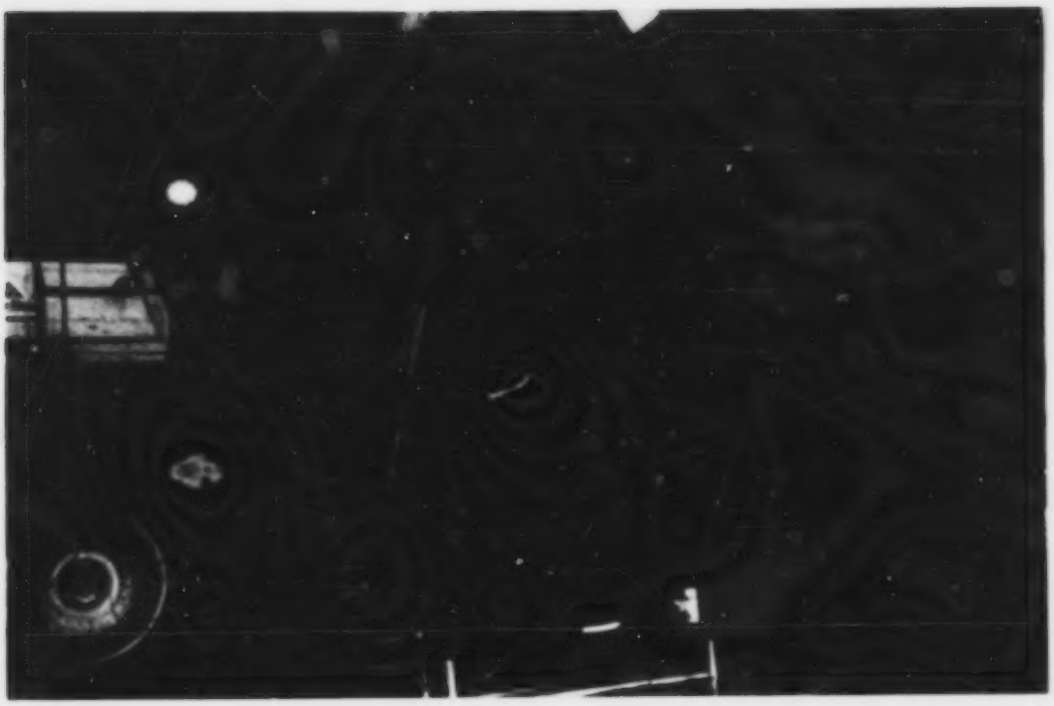


PHOTO #1

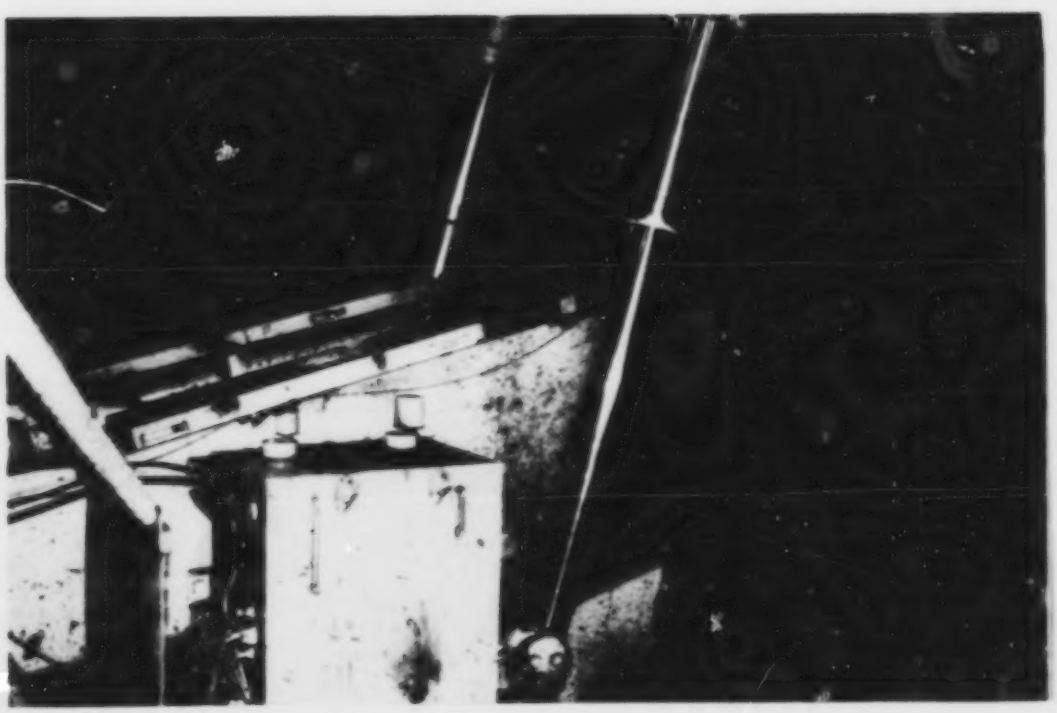


PHOTO #2

PHOTO #4

PHOTO #3

PHOTO #5

PHOTO #6

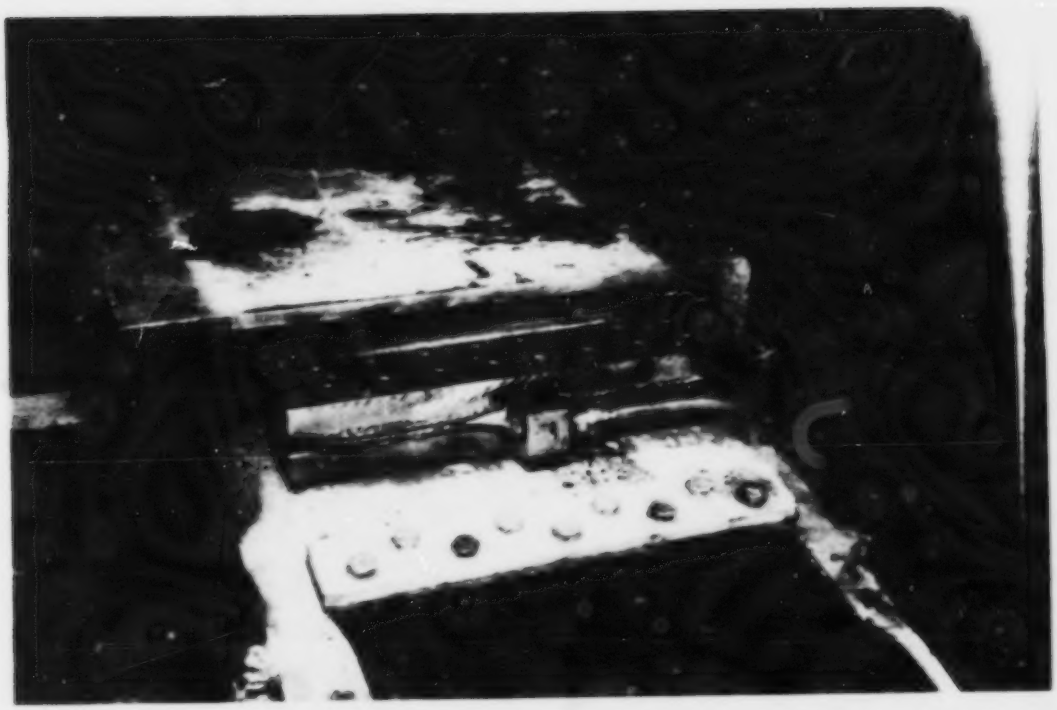


PHOTO #7

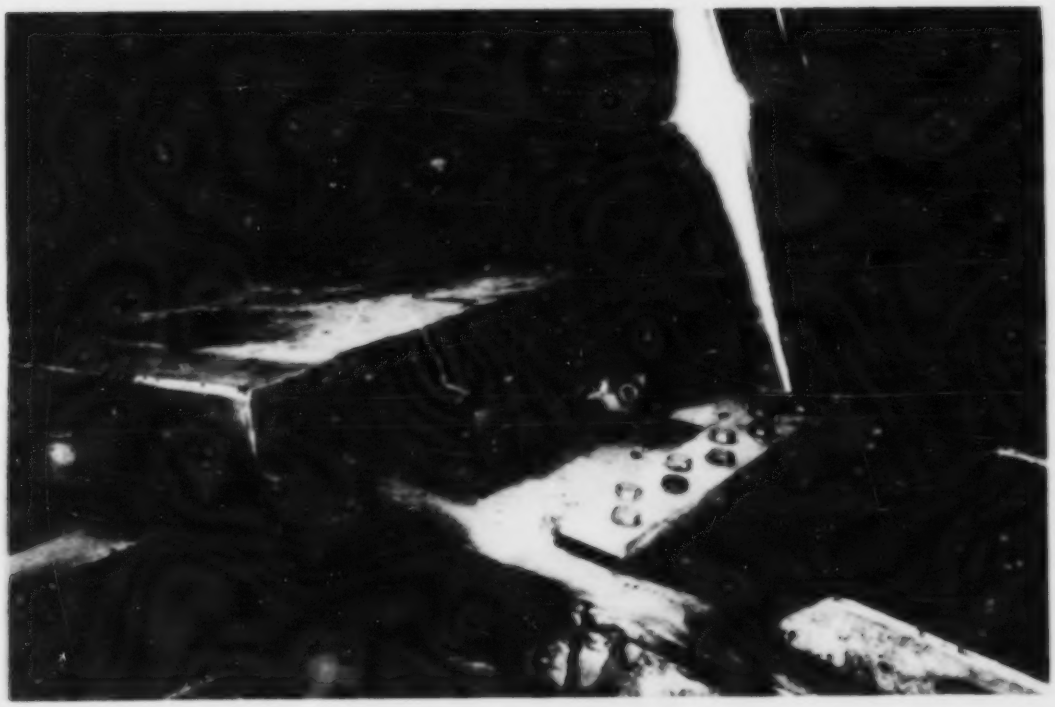


PHOTO #8

PHOTO #9

PHOTO #10

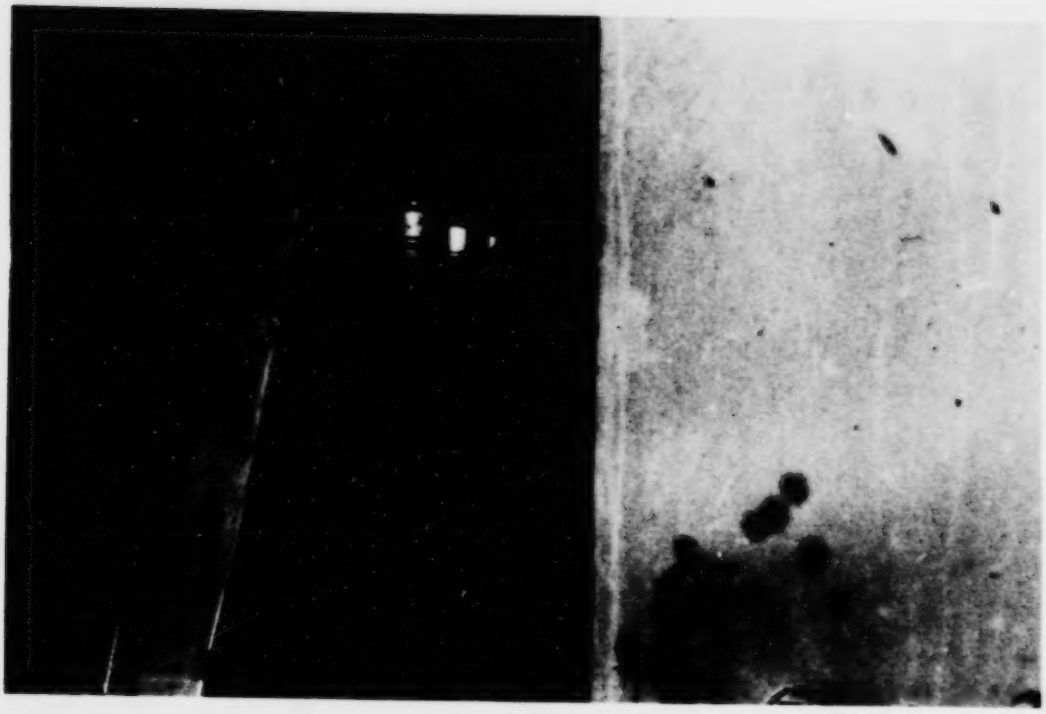


PHOTO #11

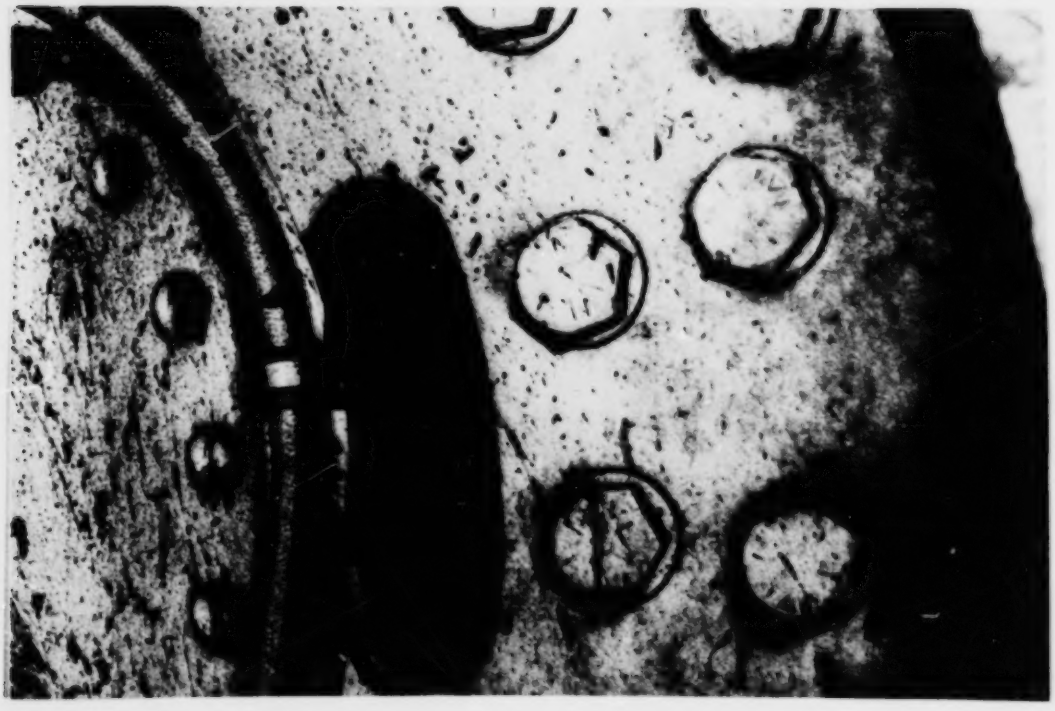


PHOTO #12

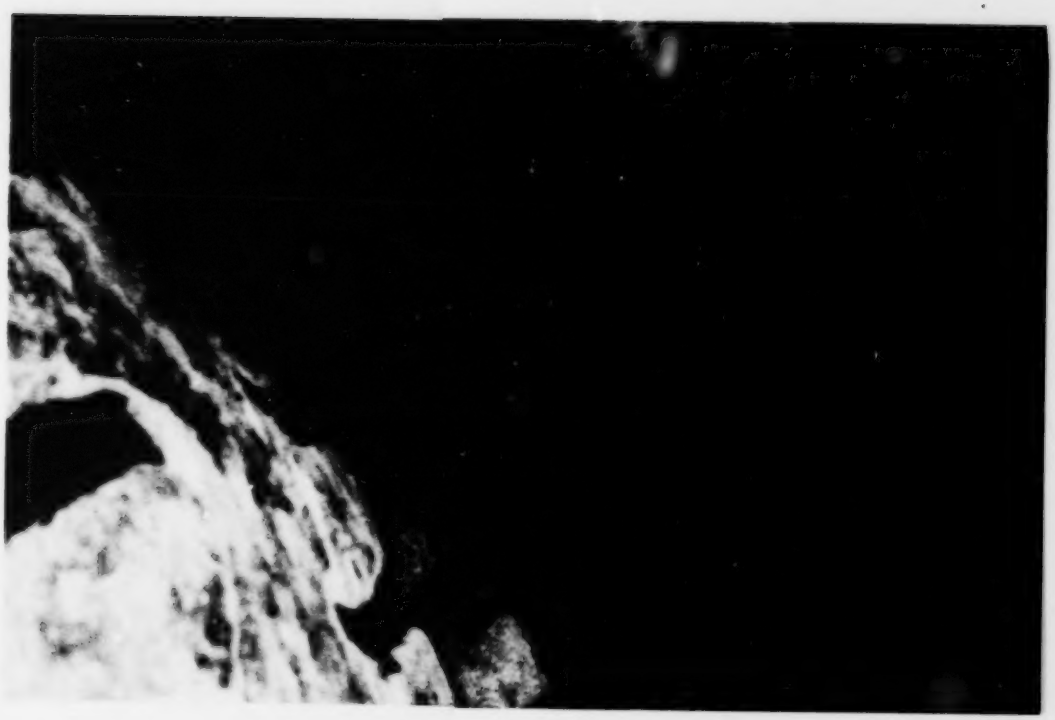


PHOTO #13

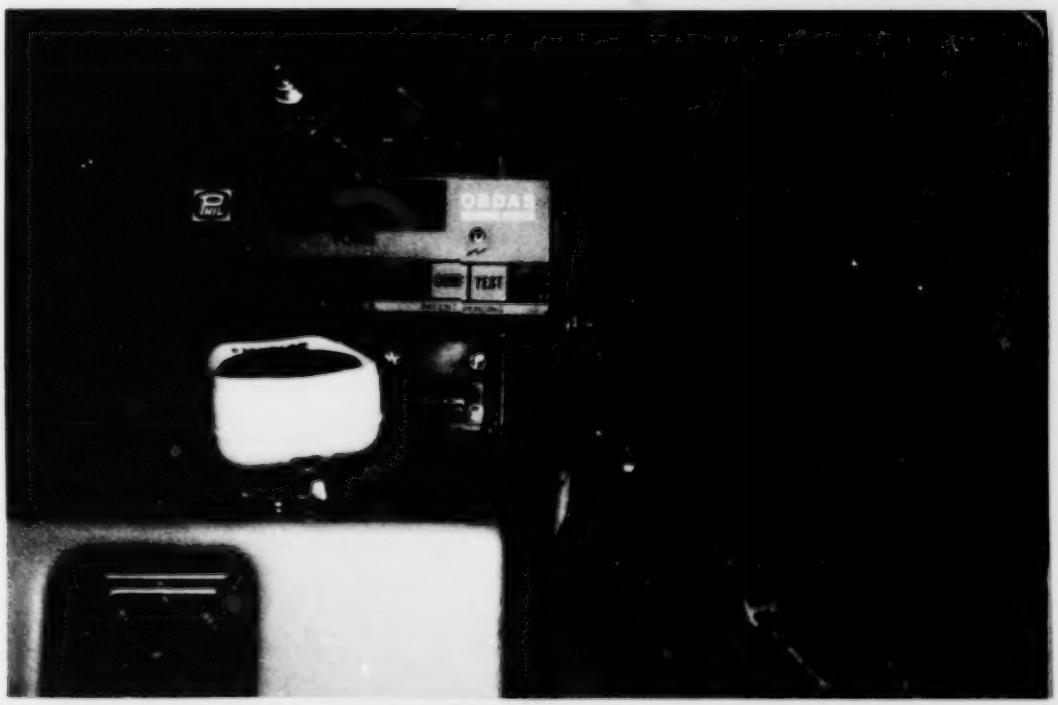


PHOTO #14

Appendices

Appendix A	OBDAS Coding
Appendix B	Data Collection Software
Appendix C	Weigh Studies
Appendix D	Time Studies
Appendix E	Haul Cycle Simulations
Appendix F	Assessment of Mechanical Downtime
Appendix G	Assessment of Operator Acceptance
Appendix H	Overview of Problems Associated with the Evaluation

APPENDIX A

OBDAS Coding

OPERATING DELAYS

To track operating delay time the following codes will be input under the OPER (operator) key function:

801 Delay due to WEATHER
802 Delay due to BLASTING
803 Delay due to MOVES (shovel re-positioning, moving cable stands)
804 Delay due to WAITING (waiting at shovel during repairs to shovel or while other trucks are being loaded)
805 Delay due to POWER (power outage at shovel)
806 Delay for SERVICING (at lube/fuel station in pit)
807 Broke-down: travelling to the shop for maintenance
808 Broke-down: waiting at pit/dump for maintenance

These codes will be entered to replace the operator's code (employee's number) when the delay occurs.

i.e.: hauling is delayed for a blast

press OPER - displays operator's code
press CLR - clears operator's code from display (and microprocessor)

press key and key to reach appropriate code 802
press ENTR when display reads 802 - enter code for a blasting delay

Once truck operation is ready to resume after the blast (delay) the truck driver will re-enter his operator code.

MAINTENANCE DOWN TIME

Maintenance down time will also be accounted for on units 6126 and 6127 through OBDAS by using the following codes to be input under the OPER key function by the maintenance department (mechanic, electrician, etc.) or truck driver (ie: in the case of tire repairs by CROWN):

Code	Component
901	Engine
902	Drive Train
903	Undercarriage (not used for trucks)
904	Steering and Hydraulics
905	Wear Items
906	Structural and Frame
907	Tires
908	Cab and Auto Electrical
909	Electrical Control System
910	Generators/Alternators/Motors
911	Wheel Motors
912	A.C. Power
913	Service Group
914	Lubrication and Equipment Services
915	Fuel/Power
916	Accidents and Damage
917	OBDAS
918	Repair complete - ready to operate

These codes will be entered to replace the operators or delay code as described above in entering a delay code.

Completion of maintenance down time will be noted by maintenance entering the 918 code (truck at ready-line) or by a truck driver entering his operator code.

NOTE: A maintenance down time code 917 is included for work required on the OBDAS system.

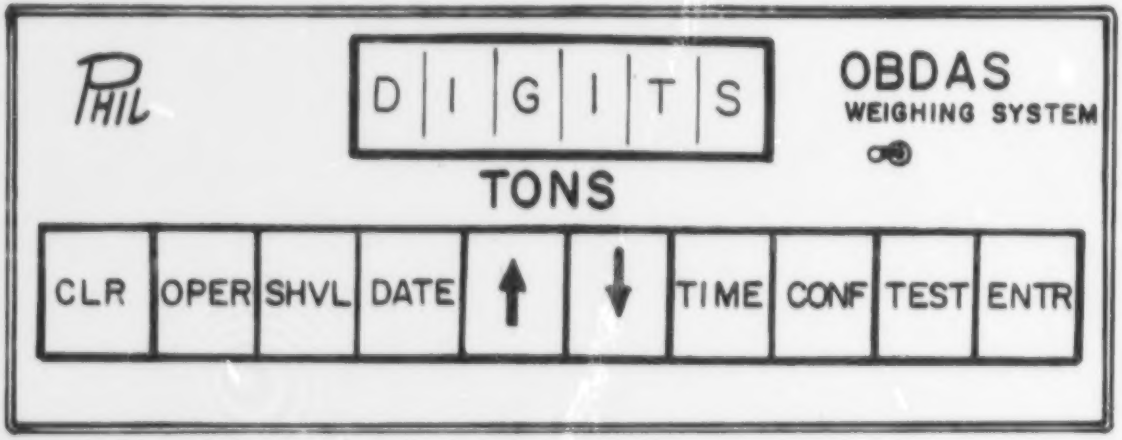
MATERIAL DESTINATION

The shovel code (entered through the SHVL key) will be expanded to include a code for material destination (assume that if material destination is given material type can be determined). The following are the codes for shovel assignment and destination:

Code	Shovel (Loader)	Code	Destination
1	Diesel Demag (6001)	01	ROM
2	Electric Demag (6002)	02	D2 Dump
3	P&H 2800 (6003)	03	NO Pit (backfill)
21	L-800 FEL (6021)	04	JK Pit (backfill)
22	L-800 FEL (6022)	05	D5 Dump
31	992C FEL (6031)	06	CD1 Pit (backfill)
		07	Haul Road Fill
		08	Other
		09	Topsoil Stockpile

i.e. 1) If a truck has been assigned to haul from the P&H 2800 to D5 dump the appropriate code to enter through the SHVL key is 305.

2) If the truck has been assigned to haul from the 992C FEL (which is loading topsoil) to a topsoil stockpile location the appropriate code is 3109.



View of OBDAS Microprocessor keypad used for data (coding) entry.

APPENDIX B

Data Collection Software

```
      PROGRAM DCOLL4
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C                                                                              C
C              TRUCK MANAGEMENT SYSTEM DATA COLLECTION SOFTWARE                C
C                                                                              C
C  This software polls the OBDAS units on the trucks sequentially. When a unit C
C  has data to ship, this is received and stored along with system time. Each  C
C  line of data has a checksum and unit number which are used to verify the    C
C  data. If the data is bad, the complete message is sent again by repolling   C
C  Once the data is correctly received, an "OKAY" is sent to the unit and, if  C
C  this is received back as an echo, we go on to poll the next unit. Otherwise C
C  the "OKAY" is sent again. Timing is critical and the timing parameters are  C
C  found in namelist TIMES.DAT. Note that this software is used with a DZ-11   C
C  interface on a VAX-11/750 and that a different approach may be more effect- C
C  ive on another computer and interface.                                      C
C                                                                              C
C                                                                              C
C  The communications port which is connected to the RF Modem (Bell 212 Stand.)C
C  is define by:           $ DEFINE/USER_MODE HOST_MODEM TTC7:                 C
C                                                                              C
C  The local display terminal, if required is defined by:                      C
C                          $ DEFINE/USER_MODE LOCAL_DISPLAY TTA2:              C
C                                                                              C
C                                                                              C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      IMPLICIT INTEGER (A-Z)
      PARAMETER CR=CHAR(13)          ! CARRIAGE RETURN
      PARAMETER LF=CHAR(10)          ! LINE FEED
      PARAMETER CRLF=CR//LF
      INTEGER*4 ELAPSTIME(2)
      CHARACTER*13 ELCHAR
      BYTE SET_BLOCK(8)
      CHARACTER*1 POLLC(3)/'R','R','R'/
      CHARACTER DTIME*23,TKEY*16,CMD*2
      CHARACTER TESTC*4,SENDSV*12
      CHARACTER*4 LOCAL_TERM,VAX_MODEM
      CHARACTER RCVIN*64,SENDIN*22,SENDOUT*54
      CHARACTER ALLN*64
      REAL THRP,THROFF,TDUM
      INTEGER*2 RCV_STAT(4)
      REAL*8 SET_BLOCK_R
      INTEGER*2 nrtry(3)/0,0,0/
      INTEGER*2 LGRN(3)/-1,-1,-1/ ! LAST GOOD RECORD OF TRANSMISSION BLOCK
      INTEGER*2 RN(3) /0,0,0/
      LOGICAL*2 ok(3),skip(3)
      NAMELIST /TIMES/THRP,THROFF,TIMEOUT,TDUM,IVAR
      NAMELIST /PARMS/POLLC,OK,LGRN
      DIMENSION TERM_CHAR_BLOCK(2)
      COMMON VAX_MODEM
      data ok  /.true.,.true.,.true./
      data skip/.true.,.true.,.true./
      DATA TERM_CHAR_BLOCK/0,'2000'X/
      EQUIVALENCE (SET_BLOCK_R,SET_BLOCK)
      EXTERNAL ALLOCATE
      INCLUDE '($SSDEF)'
      INCLUDE '($TTDEF)'
      INCLUDE '($IODEF)'
      OPEN(11,FILE='TIMES.DAT',STATUS='OLD')
      READ(11,NML=TIMES)
      CLOSE(11)
      N=IVAR
      OPEN(12,FILE='PARMS.INV',STATUS='OLD',ORGANIZATION=
```

```
     -   'FORMATTED',RECL=14,RECORDTYPE='VARIABLE',SHARED)
         CALL REPAR(POLLC,OK,LGRN,N)
         CALL LIB$INIT_TIMER
C
C  OPEN THE MASTER DATA FILES. ONE ON EACH USER DISK AS BACKUP
C
         OPEN(22,FILE='TMSDAT.INX',STATUS='OLD',ORGANIZATION=
     -   'INDEXED',ACCESS='KEYED',KEY=(1:16:CHARACTER),FORM=
     -   'FORMATTED',RECL=66,RECORDTYPE='VARIABLE',SHARED)
         OPEN(23,FILE='dua0:[tms]TMSDAT.INX',STATUS='OLD',
     -     ORGANIZATION=
     -   'INDEXED',ACCESS='KEYED',KEY=(1:16:CHARACTER),FORM=
     -   'FORMATTED',RECL=73,RECORDTYPE='VARIABLE',SHARED)
C
C INITIALIZE REMOTE & LOCAL PARAMETERS FROM LOGICAL NAMES
C
          ISTAT=SYS$TRNLOG('HOST_MODEM',,VAX_MODEM,,,)
          ISTAT=STR$UPCASE(VAX_MODEM,VAX_MODEM)
          IF (VAX_MODEM(1:2).NE.'TT')THEN
           PRINT *,'No Logical Name For Comm. Port - Using TTC7'
           VAX_MODEM(1:4)='TTC7'
          ENDIF
C
          ISTLD=SYS$TRNLOG('LOCAL_DISPLAY',,LOCAL_TERM,,,)
          ISTAT=STR$UPCASE(LOCAL_TERM,LOCAL_TERM)
          IF (LOCAL_TERM(1:2).NE.'TT')THEN
           PRINT *,'No Logical Name For Local Display - None Used'
          ENDIF
C ALLOCATE MODEM (SUPERVISOR MODE)
         ISTAT=SYS$CMEXEC(ALLOCATE,)
         IF (.NOT.ISTAT) CALL FATAL('ALLOCATE MODEM',ISTAT)
C ASSIGN I/O CHANNEL TO LOCAL TERMINAL
         IF(ISTLD.AND.LOCAL_TERM(1:2).EQ.'TT')
     -          ISTAT=SYS$ASSIGN(LOCAL_TERM,LOCAL_CHANNEL,,)
         IF (.NOT.ISTAT) CALL FATAL('ASSIGN CHANNEL TO TERMINAL',ISTAT)
C ASSIGN I/O CHANNEL TO MODEM
         ISTAT=SYS$ASSIGN(VAX_MODEM,REMOTE_CHANNEL,,)
         IF (.NOT.ISTAT) THEN
           CALL FATAL('ASSIGN CHANNEL TO  MODEM',ISTAT)
           GO TO 99
         ENDIF
C
C POLL EACH REMOTE STATION BY: STATION<Pnn>, WHERE nn IS STATION #
C
         SENDIN(1:8)='STATION<'
         SENDIN(12:12)='>'
C
C
   48    CONTINUE
C
C AFTER RUNNING 58 MINUTES STOP JOB AND WAIT FOR RESTART
C   (REPLACED BY AUTO-KILL IN WATCH PROCEDURE)
C        CALL LIB$STAT_TIMER(1,ELAPSTIME)
C        ISTAT=SYS$ASCTIM(,ELCHAR,ELAPSTIME,)
C        IF(ELCHAR(9:10).GT.'58'.OR.ELCHAR(6:7).GT.'00')GO TO 99
C
C TRUCK LOOP
C
         DO 50 I = N,27
           NSIZ=12
           III=I
           J=I-24
           NTRIES=0
           NTRY2=0
           ENCODE(12,55,SENDIN(10:11))I
```

```
          SENDIN(9:9)=POLLC(J)
C
C BRING UP RTS
C
   56   CONTINUE
D        WRITE(6,*)' POLL:',SENDIN(1:12)
         skip(j)=.FALSE.
         RN(J)=0
   58   CONTINUE
        SET_BLOCK_R=0
        SET_BLOCK(3)=TT$M_DS_DTR
        SET_BLOCK(4)=.NOT.SET_BLOCK(3)
        ISTAT=SYS$QIOW(,%VAL(REMOTE_CHANNEL),%VAL(IO$_SETMODE.OR.
        1       IO$M_SET_MODEM.OR.IO$M_MAINT),,,,SET_BLOCK,,,,,)
        IF (.NOT.ISTAT) CALL FATAL('BRINGING UP RTS',ISTAT)
C
        CALL LIB$WAIT(TWRP)
C
C SEND OUT THE POLL
C
        ISTAT=SYS$QIOW(%VAL(21),%VAL(REMOTE_CHANNEL),
     &      %VAL(IO$_WRITEVBLK+IO$M_NOFORMAT),
     &      ,,,%REF(SENDIN),%VAL(NSIZ),,,,)
        IF (.NOT.ISTAT) CALL FATAL('POLLING STATIONS',ISTAT)
C
        CALL LIB$WAIT(TWROFF)
C
C RTS OFF
C
        SET_BLOCK_R=0
        SET_BLOCK(3)=.NOT.TT$M_DS_DTR
        SET_BLOCK(4)=.NOT.SET_BLOCK(3)
        ISTAT=SYS$QIOW(,%VAL(REMOTE_CHANNEL),%VAL(IO$_SETMODE.OR.
        1       IO$M_SET_MODEM.OR.IO$M_MAINT),,,,SET_BLOCK,,,,,)
        IF (.NOT.ISTAT) CALL FATAL('BRINGING DOWN RTS',ISTAT)
C
C ISSUE QIO FOR MODEM INPUT FROM REMOTE SYSTEM
C
   49       CONTINUE
            RCVIN=ALLN
            ISTAT=SYS$QIOW(,%VAL(REMOTE_CHANNEL),
     &         %VAL(IO$_READVBLK+IO$M_NOECHO+IO$M_TIMED),
     &        RCV_STAT,,,%REF(RCVIN),%VAL(47),
     &         %VAL(TIMEOUT),%REF(TERM_CHAR_BLOCK),,)
        IF (.NOT.ISTAT) CALL FATAL('READING DATA',ISTAT)
C
                ILEN=RCV_STAT(2)
C
        IF(SENDIN(9:9).EQ.'K')THEN
D                WRITE(6,*)' "',RCVIN(1:ILEN),'"'
         IF(ILEN.GE.5)THEN
C
C AFTER 10 TRIES GO ON TO NEXT EQUIP.
C
          NTRIES=NTRIES+1
          IF(NTRIES.GT.10)THEN
           POLLC(J)='K'
         nrtry(j)=nrtry(j)+1
          if(nrtry(j).gt.5)then
            nrtry(j)=0
            pollc(j)='R'
          endif
           CALL WRPAR(1,POLLC,OK,LGRN,III)
           GO TO 50
```

```
            DO 52 II=1,ILEN-4
             IF(RCVIN(II:II+4).EQ.SENDIN(8:12))THEN
               nrtry(j)=0
               LGRN(J)=-1
               POLLC(J)='R'
               ok(j)=.TRUE.
               CALL WRPAR(1,POLLC,OK,LGRN,III)
               CALL WRPAR(2,POLLC,OK,LGRN,III)
               CALL WRPAR(3,POLLC,OK,LGRN,III)
               GOTO 50
             ENDIF
   52       CONTINUE
           ENDIF
           IF(RCV_STAT(1).EQ,SS$_TIMEOUT)THEN
             NTRY2=NTRY2+1
             IF(NTRY2.GT.20)THEN
              pollc(j)='R'
              CALL WRPAR(1,POLLC,OK,LGRN,III)
              GO TO 50
             ENDIF
             GO TO 56
           ENDIF
           GO TO 49
          ENDIF
D               WRITE(6,*)' "',RCVIN(1:ILEN),'"'
         IF(ILEN.LE.0 .AND. .NOT.ok(j) .AND. RN(J).EQ.0)THEN
          NNT=NNT+1
          IF(NNT.GT.5)THEN
           NNT=0
           GO TO 50
          ELSE
           GO TO 56
          ENDIF
         ENDIF
         IF(RCV_STAT(1).EQ.SS$_TIMEOUT .AND. .NOT.ok(j) )THEN
           IF(skip(j))THEN
            GO TO 56
           ELSE
            GO TO 63
           ENDIF
         ENDIF
         IF(.NOT.ok(j) .AND. skip(j))GO TO 49
C
              IF(ILEN.GT.10)THEN
D               WRITE(6,*)' ILEN=',ILEN
D               WRITE(6,*)' "',RCVIN(1:ILEN),'"'
                RN(J)=RN(J)+1
                IF(LGRN(J).GE.RN(J) .AND. .NOT.ok(j))GO TO 57
                 CALL LIB$DATE_TIME(DTIME)
                 CALL TRMD(DTIME(4:6),CMO)
                 IF(DTIME(1:1).EQ.' ')DTIME(1:1)='0'
                 TKEY=DTIME(10:11)//CMO//DTIME(1:2)//DTIME(12:14)//
                   DTIME(16:17)//DTIME(19:23)
                IILEN=ILEN
                IF(IILEN.GT.47)IILEN=47
                WRITE(23,9301,ERR=57) TKEY,I,RCVIN(IFIRST:IILEN)
C
C CALCULATE THE CHECKSUM FOR 40 CHAR
C
   57            CONTINUE
                 ICHKS=0
              if(rcvin(35:35).eq.':')go to 63
              if(rcvin(40:40).eq.':')go to 63
                 IF(RCVIN(41:41).EQ.':')GO TO 63
                 IF(RCVIN(44:44).EQ.':')GO TO 63
```

```
                DO 60 IC=1,ILEN
                  IF(RCVIN(IC:IC).EQ.'@')GOTO 66
                  ICHKS=ICHKS+ICHAR(RCVIN(IC:IC))
   60           CONTINUE
                GOTO 64
   66           CONTINUE
                ILEN=IC-1
                IC=IC+1
D               WRITE(6,*)' ICHKS= ',ICHKS
C
C COMPARE WITH THAT ON RECORD AND CHECK STATION NO.
C
                DECODE(6,62,RCVIN(IC:IC+3),ERR=64)JCHKS
   62           FORMAT(I4)
D               WRITE(6,*)' JCHKS=',JCHKS
                IF(ICHKS+15.EQ.JCHKS .AND.RCVIN(2:2).EQ.':')GO TO 68
                IF(ICHKS-177.EQ.JCHKS .AND.RCVIN(2:2).EQ.':')GO TO 68
                IF(ICHKS.NE.JCHKS.OR.RCVIN(IC+4:IC+5).NE.SENDIN(10:11))
     -            GOTO 64
   68           CONTINUE
                IFIRST=1
D              IF(.NOT.ok(j))WRITE(6,*)'LGRN, RN =',LGRN(J),RN(J)
               IF(LGRN(J).GE.RN(J) .AND. .NOT.ok(j))THEN
                 IF(RCV_STAT(1).NE.SS$_TIMEOUT)GO TO 49
                 IF(RCV_STAT(1).EQ.SS$_TIMEOUT)GO TO 67
               ENDIF
C
C GET SYSTEM TIME AT END OF RECORD
C
                CALL LIB$DATE_TIME(DTIME)
D               TYPE *,DTIME
                CALL TRMO(DTIME(4:6),CMO)
                IF(DTIME(1:1).EQ.' ')DTIME(1:1)='0'
                TKEY=DTIME(10:11)//CMO//DTIME(1:2)//DTIME(12:14)//
     -             DTIME(16:17)//DTIME(19:23)
 9301           FORMAT(A16,' TRUCK #',I2,A)
                IF(ILEN.GT.40)ILEN=40
                WRITE(22,9301) TKEY,I,RCVIN(IFIRST:ILEN) !WRITE INTO FILE
C                WRITE(23,9301) TKEY,I,RCVIN(IFIRST:ILEN) !WRITE INTO FILE
                LGRN(J)=RN(J)
                CALL WRPAR(3,POLLC,OK,LGRN,III)
C
C  LOCAL TERMINAL OUTPUT
C
                  IF(ISTLD.AND.LOCAL_TERM(1:2).EQ.'TT')THEN
      SENDOUT(1:54)=CRLF//' TRUCK #'//SENDIN(10:11)//'  '//RCVIN(1:ILEN)
                    ISTAT=SYS$QIOW(%VAL(21),%VAL(LOCAL_CHANNEL),
     &                 %VAL(IO$_WRITEVBLK+IO$M_NOFORMAT),
     &                 ,,,%REF(SENDOUT),%VAL(54),,,,)
      IF (.NOT.ISTAT) CALL FATAL('WRITING TO LOCAL DISPLAY',ISTAT)
                  ENDIF
                ENDIF
  67       CONTINUE
           IF(RCV_STAT(1).EQ.SS$_TIMEOUT)THEN
D           PRINT *,'  Timeout Encountered'
C
C  SEND OK AND GO ON TO NEXT TRUCK
C
  63        CONTINUE
            IF(RN(J).GT.0)THEN
             SENDIN(9:9)='K'
             POLLC(J)='K'
              CALL WRPAR(1,POLLC,OK,LGRN,III)
             GO TO 56
            ELSE
```

```
            CALL WRPAR(1,POLLC,OK,LGRN,III)
           GO TO 50
          ENDIF
         ELSE
          GO TO 49
         ENDIF
C
C  NOT OKAY SO REPOLL AFTER READING TO TIMEOUT
C
   64    CONTINUE
            ok(j)=.FALSE.
            skip(j)=.TRUE.
             CALL WRPAR(2,POLLC,OK,LGRN,III)
            GOTO 49
C
  50    CONTINUE
C
C REPEAT LOOP
C
        N=IVAR
        GO TO 48
C
  99    CONTINUE
        STOP
        END
C
        FUNCTION ALLOCATE(A1)
        IMPLICIT INTEGER(A-Z)
        CHARACTER*4 LOCAL_TERM,VAX_MODEM
        COMMON VAX_MODEM
        ALLOCATE=SYS$ALLOC(VAX_MODEM,,,%VAL(2))
        RETURN
        ENTRY DEALLOCATE(A1)
        DEALLOCATE=SYS$DALLOC(VAX_MODEM,%VAL(2))
        RETURN
        END
C
        SUBROUTINE TRMO(MOIN,MOUT)
        CHARACTER MOIN*3,MOUT*2,MORF(12)*3
        DATA MORF/'JAN','FEB','MAR','APR','MAY','JUN',
     -           'JUL','AUG','SEP','OCT','NOV','DEC'/
        MOUT='OO'
        DO 10 I=1,12
           IF(MOIN.EQ.MORF(I))THEN
           ENCODE(2,11,MOUT)I
   11      FORMAT(I2)
           IF(MOUT(1:1).EQ.' ')MOUT(1:1)='0'
           GO TO 12
           ENDIF
   10   CONTINUE
   12   CONTINUE
        RETURN
        END
C
        SUBROUTINE ERROR(STRING,MSGID)
        IMPLICIT INTEGER(A-Z)
        CHARACTER*(*) STRING
        CHARACTER*80 MESSAGE
        TYPE *,' ERROR ON ',STRING
        CALL SYS$GETMSG(%VAL(MSGID),MSGLEN,MESSAGE,%VAL(15),)
        TYPE *,MESSAGE(1:MSGLEN),CRLF
        RETURN
        END
C
        SUBROUTINE FATAL(STRING,MSGID)
```

AUTOREPORT

```
      CHARACTER*(*) STRING
      CALL ERROR(STRING,MSGID)
      RETURN
      END
C
      SUBROUTINE WRPAR(I,P,O,L,N)
      CHARACTER*2 IC,IC4
      CHARACTER*1 P(3)
      LOGICAL*2   O(3)
      INTEGER*2   L(3)
      IC4=' 4'
      ENCODE(2,5,IC)I
    5 FORMAT(I2)
      READ(12,9,KEY=IC,ERR=30)IK
    9 FORMAT(I2)
      IF(I.EQ.1)REWRITE(12,10)IC,P
      IF(I.EQ.2)REWRITE(12,11)IC,O
      IF(I.EQ.3)REWRITE(12,12)IC,L
      GO TO 20
   30 CONTINUE
      IF(I.EQ.1)WRITE(12,10)IC,P
      IF(I.EQ.2)WRITE(12,11)IC,O
      IF(I.EQ.3)WRITE(12,12)IC,L
   20 CONTINUE
      READ(12,9,KEY=IC4,ERR=40)IK
      REWRITE(12,13)IC4,N
      GO TO 50
   40 CONTINUE
      WRITE(12,13)IC4,N
   50 CONTINUE
   10 FORMAT(A2,3(1X,A1))
   11 FORMAT(A2,3(1X,L1))
   12 FORMAT(A2,3(1X,I3))
   13 FORMAT(A2,1X,I3)
      RETURN
      END
C
      SUBROUTINE REPAR(P,O,L,N)
      CHARACTER*2 IC
      CHARACTER*1 P(3)
      LOGICAL*2   O(3)
      INTEGER*2   L(3)
      DO 20 I=1,4
      ENCODE(2,5,IC)I
    5 FORMAT(I2)
      IF(I.EQ.1)READ(12,10,KEY=IC)P
      IF(I.EQ.2)READ(12,11,KEY=IC)O
      IF(I.EQ.3)READ(12,12,KEY=IC)L
      IF(I.EQ.4)READ(12,13,KEY=IC)N
   10 FORMAT(2X,3(1X,A1))
   11 FORMAT(2X,3(1X,L1))
   12 FORMAT(2X,3(1X,I3))
   13 FORMAT(2X,1X,I3)
   20 CONTINUE
      RETURN
      END
```

AUTOREPORT

APPENDIX C

Weigh Studies

C2

NOVEMBER 1986 WEIGH STUDY

LOADER# 6003
[redacted] 30yd
MATERAL WASTE

LOADED WEIGHTS

NOV 13,1986
[redacted] A
UNIT 6124
MODEL 317ED-R170

Run Number	1	2	3	4	5	6	7	8	9	10	11	12	AVERAGE
Fr. axle wt.	182,400	190,200	188,500	195,000	192,600	208,000	208,000	184,100	187,200	217,000	204,000	186,500	195,292
Dr. axle wt.	335,000	335,000	321,000	330,000	324,000	338,000	334,000	332,000	324,000	324,000	312,000	321,000	327,500
Gross wt.	517,400	525,200	509,500	525,000	516,600	546,000	542,000	516,100	511,200	541,000	516,000	507,500	522,792
Net wt.	247,900	247,900	247,900	247,900	250,400	250,400	250,400	250,400	250,400	250,400	250,400	250,400	249,150
Payload	269,500	277,300	261,600	277,100	266,200	295,600	291,600	265,700	260,800	290,600	265,600	257,100	273,642
TONS	134.75	138.65	130.80	138.55	133.10	147.80	145.80	132.85	130.40	145.30	132.80	128.55	136.82
B.C.M	48.13	49.52	46.72	49.48	47.54	52.79	52.07	47.45	46.57	51.89	47.43	45.91	48.87
Passes	4	4	4	4	4	4	4	4	4	4	4	4	4

LOADER# 6003
SIZE 30yd
MATERAL WASTE

LOADED WEIGHTS
lbs

NOV 13,1986
SHIFT A
UNIT 6121
MODEL 317ED-R170

C3

Run Number	1	2	3	4	5	6	7	8	9	10	11	12	AVERAGE
Fr. axle wt.	205,000	215,000	228,000	222,000	226,000	198,000	213,000	183,500	205,000	201,000	195,000	198,000	207,458
Dr. axle wt.	316,000	322,000	373,000	322,000	329,000	318,000	333,000	323,000	314,000	316,000	322,000	295,000	323,583
Gross wt.	521,000	537,000	601,000	544,000	555,000	516,000	546,000	506,500	519,000	517,000	517,000	493,000	531,042
Net wt.	254,400	254,400	254,400	254,400	254,400	254,400	254,400	254,400	254,400	254,400	254,400	254,400	254,400
Payload	266,600	282,600	346,600	289,600	300,600	261,600	291,600	252,100	264,600	262,600	262,600	238,600	276,642
TONS	133.30	141.30	173.30	144.80	150.30	130.80	145.80	126.05	132.30	131.30	131.30	119.30	138.32
B.C.M	47.61	50.47	61.90	51.72	53.68	46.72	52.07	45.02	47.25	46.89	46.89	42.61	49.40
Passes	3	4	5	4	4	4	4	4	4	4	4	4	4

LOADER# 6003
SIZE 30yd
MATERAL WASTE

LOADED WEIGHTS
lbs

NOV 14,1986
SHIFT B
UNIT 6127
MODEL 317ED-R170

Run Number	1	2	3	4	5	6	7	8	9	10	11	12	AVERAGE
Fr. axle wt.	177,400	172,800	163,000	175,200	191,200	174,400	164,800	213,000	178,900	190,900	189,000	207,000	183,133
Dr. axle wt.	236,000	230,000	294,000	278,000	320,000	272,000	281,000	370,000	313,000	334,000	338,000	346,000	301,000
Gross wt.	413,400	402,800	457,000	453,200	511,200	446,400	445,800	583,000	491,900	524,900	527,000	553,000	484,133
Net wt.	222,500	222,500	222,500	222,500	236,100	236,100	236,100	236,100	236,100	236,100	236,100	236,100	229,300
Payload	190,900	180,300	234,500	230,700	275,100	210,300	209,700	346,900	255,800	288,800	290,900	316,900	254,833
TONS	95.45	90.15	117.25	115.35	137.55	105.15	104.85	173.45	127.90	144.40	145.45	158.45	127.42
B.C.M	34.09	32.20	41.88	41.20	49.13	37.55	37.45	61.95	45.68	51.57	51.95	56.59	45.51
Passes	4	4	4	4	4	4	4	4.5	4	4	4	4	4

LOADER# 6001
SIZE 30yd
MATERAL WASTE

LOADED WEIGHTS
lbs

NOV 14,1986
SHIFT B
UNIT 6126
MODEL 317ED-R170

Run Number	1	2	3	4	5	6	7	8	9	10	11	12	AVERAGE
Fr. axle wt.	156,000	172,700	200,000	185,200	191,100	182,000	177,600	197,000	197,000	205,000	195,000	174,000	186,050
Dr. axle wt.	245,000	321,000	226,000	289,000	304,000	302,000	326,000	333,000	323,000	309,000	328,000	321,000	302,250
Gross wt.	401,000	493,700	426,000	474,200	495,100	484,000	503,600	530,000	520,000	514,000	523,000	495,000	488,300
Net wt.	231,600	231,600	231,600	231,600	231,600	231,600	231,600	231,600	231,600	231,600	231,600	231,600	231,600
Payload	169,400	262,100	194,400	242,600	263,500	252,400	272,000	298,400	288,400	282,400	291,400	263,400	256,700
TONS	84.70	131.05	97.20	121.30	131.75	126.20	136.00	149.20	144.20	141.20	145.70	131.70	128.35
B.C.M	30.25	46.81	34.72	43.32	47.06	45.07	48.57	53.29	51.50	50.43	52.04	47.04	45.84
Passes	4	4	4	4	4	4	4	4	4	4	4	4	4

LOADER# 6003
SIZE 30yd
MATERAL WASTE

LOADED WEIGHTS
lbs

NOV 14,1986
SHIFT B
UNIT 6123
MODEL 317EP-R170

Run Number	1	2	3	4	5	6	7	8	9	10	11	12	AVERAGE
Fr. axle wt.	174,300	166,600	174,400	181,700	184,800	215,000	176,600	198,000	197,000	198,000	186,500	197,000	187,492
Dr. axle wt.	255,000	263,000	280,000	314,000	281,000	342,000	322,000	340,000	368,000	350,000	343,000	348,000	317,167
Gross wt.	429,300	429,600	454,400	495,700	465,800	557,000	498,600	538,000	565,000	548,000	529,500	545,000	504,658
Net wt.	230,800	230,800	230,800	230,800	230,800	230,800	230,800	230,800	230,800	230,800	230,800	230,800	230,800
Payload	198,500	198,800	223,600	264,900	235,000	326,200	267,800	307,200	334,200	317,200	298,700	314,200	273,858
TONS	99.25	99.40	111.80	132.45	117.50	163.10	133.90	153.60	167.10	158.60	149.35	157.10	136.93
B.C.M	35.45	35.50	39.93	47.31	41.97	58.25	47.82	54.86	59.68	56.64	53.34	56.11	48.91
Passes	4	4	4	4	4	4	4	4	4	4	4	4	4

LOADER# 6001
SIZE 30yd
MATERAL WASTE

LOADED WEIGHTS
lbs

NOV 14,1986
SHIFT B
UNIT 6120
MODEL 317EP-R170

Run Number	1	2	3	4	5	6	7	8	9	10	11	12	AVERAGE
Fr. axle wt.	179,500	200,000	181,000	203,000	202,000								194,700
Dr. axle wt.	329,000	330,000	346,000	312,000	302,000								323,800
Gross wt.	508,500	530,000	527,000	515,000	504,000								518,500
Net wt.	239,000	239,000	239,000	239,000	239,000								239,000
Payload	269,500	299,000	288,000	276,000	265,000								279,500
TONS	134.75	149.50	144.00	138.00	132.50								139.75
B.C.M	48.13	53.39	51.43	49.29	47.32								49.91
Passes	4	4	4	4	4								4

LOADER# 6003
SIZE 30yd
MATERAL WASTE

LOADED WEIGHTS
lbs

NOV 14,1986
SHIFT B
UNIT 6124
MODEL 317ED-R170

Run Number	1	2	3	4	5	6	7	8	9	10	11	12	AVERAGE
Fr. axle wt.	194,000	196,000	193,300	207,000	204,000	193,000							197,883
Dr. axle wt.	310,000	297,000	319,000	324,000	363,000	324,000							322,833
Gross wt.	504,000	493,000	512,300	531,000	567,000	517,000							520,717
Net wt.	244,800	244,800	244,800	244,800	244,800	244,800							244,800
Payload	259,200	248,200	267,500	286,200	322,200	272,200							275,917
TONS	129.60	124.10	133.75	143.10	161.10	136.10							137.96
B.C.M	46.29	44.32	47.77	51.11	57.54	48.61							49.27
Passes	4	4	4	4	4	4							4

C6

LOADER# 6003
SIZE 30yd
MATERAL WASTE

LOADED WEIGHTS
lbs

NOV 14,1986
SHIFT B
UNIT 6121
MODEL 317ED-R170

Run Number	1	2	3	4	5	6	7	8	9	10	11	12	AVERAGE
Fr. axle wt.	206,000	196,000											201,000
Dr. axle wt.	322,000	346,000											334,000
Gross wt.	528,000	542,000											535,000
Net wt.	239,500	239,500											239,500
Payload	288,500	302,500											295,500
TONS	144.25	151.25											147.75
B.C.M	51.52	54.02											52.77
Passes	4	4											4

DER# 6003
E 30yd
ERAL WASTE

LOADED WEIGHTS
lbs

NOV 20,1986
SHIFT A
UNIT 6120
MODEL 317ED-R170

n Number	1	2	3	4	5	6	7	8	9	10	11	12	AVERAGE
. axle wt.	183,600	187,500	187,300										186,133
. axle wt.	261,000	295,000	288,000										281,333
Gross wt.	444,600	482,500	475,300										467,467
Net wt.	238,300	238,300	238,300										238,300
Payload	206,300	244,200	237,000										229,167
TONS	103.15	122.10	118.50										114.58
B.C.M	36.84	43.61	42.32										40.92
Passes	4	4	4										4

C7

ADER# 6003
IZE 30yd
ITERAL WASTE

LOADED WEIGHTS
lbs

NOV 20,1986
SHIFT A
UNIT 6121
MODEL 317ED-R170

un Number	1	2	3	4	5	6	7	8	9	10	11	12	AVERAGE
r. axle wt.	201,000												201,000
r. axle wt.	290,000												290,000
Gross wt.	491,000												491,000
Net wt.	242,800												242,800
Payload	248,200												248,200
TONS	124.10												124.10
B.C.M	44.32												44.32
Passes	4												4

LOADER# 6003
SIZE 30yd
MATERAL WASTE

LOADED WEIGHTS
lbs

NOV 20,1986
SHIFT A
UNIT 6126
MODEL 317ED-R170

Run Number	1	2	3	4	5	6	7	8	9	10	11	12	AVERAGE
Fr. axle wt.	182,400												182,400
Dr. axle wt.	284,000												284,000
Gross wt.	466,400												466,400
Net wt.	236,700												236,700
Payload	229,700												229,700
TONS	114.85												114.85
B.C.M	41.02												41.02
Passes	4												4

LOADER# 6003
SIZE 30yd
MATERAL WASTE

LOADED WEIGHTS
lbs

NOV 25,1986
SHIFT D
UNIT 6121
MODEL 317ED-R170

Run Number	1	2	3	4	5	6	7	8	9	10	11	12	AVERAGE
Fr. axle wt.	184,300	190,600	185,300	176,000	172,400	177,000	182,300	197,000					183,113
Dr. axle wt.	293,000	288,000	277,000	260,000	267,000	283,000	274,000	312,000					281,750
Gross wt.	477,300	478,600	462,300	436,000	439,400	460,000	456,300	509,000					464,863
Net wt.	240,300	240,300	240,300	240,300	240,300	240,300	240,300	240,300					238,300
Payload	237,000	238,300	222,000	195,700	199,100	219,700	216,000	268,700					226,563
TONS	118.50	119.15	111.00	97.85	99.55	109.85	108.00	134.35					113.28
B.C.M	42.32	42.56	39.64	34.95	35.55	39.23	38.57	47.98					40.46
Passes	4	4	4	4	4	4	4	4					4

LOADER# 6003
SIZE 30yd
MATERAL WASTE

LOADED WEIGHTS
lbs

NOV 25,1986
SHIFT D
UNIT 6126
MODEL 317ED-R170

Run Number	1	2	3	4	5	6	7	8	9	10	11	12	AVERAGE
Fr. axle wt.	185,300	205,000	194,300	188,600	210,000								196,640
Dr. axle wt.	283,000	313,000	290,000	274,000	304,000								292,800
Gross wt.	468,300	518,000	484,300	462,600	514,000								489,440
Net wt.	258,500	258,500	258,500	258,500	258,500								258,500
Payload	209,800	259,500	225,800	204,100	255,500								230,940
TONS	104.90	129.75	112.90	102.05	127.75								115.47
B.C.M	37.47	46.34	40.32	36.45	45.63								41.24
Passes	4	4	4	4	4								4

LOADER# 6003
SIZE 30yd
MATERAL WASTE

LOADED WEIGHTS
lbs

NOV 25,1986
SHIFT D
UNIT 6122
MODEL 317ED-R170

Run Number	1	2	3	4	5	6	7	8	9	10	11	12	AVERAGE
Fr. axle wt.	172,200	196,000	196,000										188,100
Dr. axle wt.	256,000	296,000	298,000										283,333
Gross wt.	428,300	492,000	494,000										471,433
Net wt.	241,700	241,700	241,700										241,700
Payload	186,600	250,300	252,300										229,733
TONS	93.30	125.15	126.15										114.87
B.C.M	33.32	44.70	45.04										41.03
Passes	4	4	4										4

LOADER# 6003
SIZE 30yd
MATERAL WASTE

LOADED WEIGHTS
lbs

NOV 26,1986
SHIFT C
UNIT 6123
MODEL 317ED-R170

Run Number	1	2	3	4	5	6	7	8	9	10	11	12	AVERAGE
Fr. axle wt.	174,700	184,300	191,200	203,000	189,900	189,100	199,000	193,300	211,000	193,900	207,000	186,500	193,575
Br. axle wt.	280,000	307,000	366,000	342,000	344,000	333,000	342,000	319,000	345,000	342,000	351,000	320,000	332,583
Gross wt.	454,700	491,300	557,200	545,000	533,900	522,100	541,000	512,300	556,000	535,900	558,000	506,500	526,158
Net wt.	238,300	238,300	238,300	238,300	238,300	238,300	238,300	238,300	238,300	238,300	238,300	238,300	238,300
Payload	216,400	253,000	318,900	306,700	295,600	283,800	302,700	274,000	317,700	297,600	319,700	268,200	287,858
TONS	108.20	126.50	159.45	153.35	147.80	141.90	151.35	137.00	158.85	148.80	159.85	134.10	143.93
B.C.M	38.64	45.18	56.95	54.77	52.79	50.68	54.06	48.93	56.73	53.14	57.09	47.89	51.41
Passes	4	4	4	4	4	4	4	4	4	4	4	4	4

LOADER# 6003
SIZE 30yd
MATERAL WASTE

LOADED WEIGHTS
lbs

NOV 26,1986
SHIFT C
UNIT 6125
MODEL 317ED-R170

Run Number	1	2	3	4	5	6	7	8	9	10	11	12	AVERAGE
Fr. axle wt.	196,000	195,000	191,100	181,900	192,300	188,600	187,100	195,000	186,900	190,400	189,100	190,300	190,308
Br. axle wt.	299,000	369,000	317,000	338,000	323,000	281,000	295,000	307,000	319,000	344,000	310,000	342,000	320,333
Gross wt.	495,000	564,000	508,100	519,900	515,300	469,600	482,100	502,000	505,900	534,400	499,100	532,300	510,642
Net wt.	251,200	251,200	251,200	251,200	251,200	251,200	251,200	251,200	251,200	251,200	251,200	251,200	251,200
Payload	243,800	312,800	256,900	268,700	264,100	218,400	230,900	250,800	254,700	283,200	247,900	281,100	259,442
TONS	121.90	156.40	128.45	134.35	132.05	109.20	115.45	125.40	127.35	141.60	123.95	140.55	129.72
B.C.M	43.54	55.86	45.88	47.98	47.16	39.00	41.23	44.79	45.48	50.57	44.27	50.20	46.33
Passes	4	4	4	4	4	4	4	4	4	4	4	4	4

LOADER# 6003
SIZE 30yd
MATERAL WASTE

LOADED WEIGHTS
lbs

NOV 26,1986
SHIFT C
UNIT 6122
MODEL 317ED-R170

Run Number	1	2	3	4	5	6	7	8	9	10	11	12	AVERAGE
Fr. axle wt.	174,300	190,700	198,000	196,000	186,300	191,100	180,200	207,000	181,500	201,000			190,610
Br. axle wt.	339,000	344,000	375,000	333,000	358,000	375,000	320,000	309,000	356,000	343,000			345,200
Gross wt.	513,300	534,700	573,000	529,000	544,300	566,100	500,200	516,000	537,500	544,000			535,810
Net wt.	247,900	247,900	247,900	247,900	247,900	247,900	247,900	247,900	247,900	247,900			247,900
Payload	265,400	286,800	325,100	281,100	296,400	318,200	252,300	268,100	289,600	296,100			287,910
TONS	132.70	143.40	162.55	140.55	148.20	159.10	126.15	134.05	144.80	148.05			143.96
B.C.M	47.39	51.22	58.06	50.20	52.93	56.82	45.06	47.88	51.72	52.86			51.41
Passes	4	4	4	4	4	4	4	4	4	4			4

LOADER# 6003
SIZE 30yd
MATERAL WASTE

LOADED WEIGHTS
STUDY AVERAGES
lbs

NOV 13:26:1986
MODEL 317ED-R170

C11

Study Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Fr. axle wt.	195,292	207,458	183,133	186,050	187,492	194,700	197,883	201,000	186,133	201,000	182,400	183,133	196,640	188,100	193,575	190,300	190,610
Br. axle wt.	327,500	323,583	301,000	302,250	317,167	323,800	322,833	334,000	281,333	290,000	284,000	281,750	292,800	283,333	332,583	320,333	345,200
Gross wt.	522,792	531,041	484,133	488,300	504,659	518,500	520,716	535,000	467,466	491,000	466,400	464,883	489,440	471,433	526,158	510,641	535,810
Net wt.	249,150	254,400	229,300	231,600	230,800	239,000	244,800	239,500	238,300	242,800	236,700	238,300	258,500	241,700	238,300	251,200	247,900
Payload	273,642	276,641	254,833	256,700	273,859	279,500	275,916	295,500	229,166	248,200	229,700	226,583	230,940	229,733	287,858	259,441	287,910
TONS	136.82	138.32	127.42	128.35	136.93	139.75	137.96	147.75	114.58	124.10	114.85	113.29	115.47	114.87	143.93	129.72	143.96
B.C.M	48.87	49.40	45.51	45.84	48.91	49.91	49.27	52.77	40.92	44.32	41.02	40.46	41.24	41.03	51.41	46.33	51.41
Passes	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4

OVERALL STUDY AVERAGE

No. of Studies	17
Fr. axle wt.	192,053
Dr. axle wt.	309,616
Gross wt.	501,669
Net wt.	241,897
Payload	259,772
TONS	129.89
B.C.M	46.39
Passes	4

C13

JANUARY 1987 WEIGH STUDY

[redacted] 30yd
MATERAL WASTE

[redacted]C
UNIT 6126
MODEL 317ED-R170

Run Number	1	2	3	4	5	6	7	8	9	10	11	AVERAGE
Fr. axle wt.	182,800	166,300	208,000	206,000	218,000	202,000						197,183
Dr. axle wt.	355,000	343,000	363,000	385,000	365,000	375,000						364,333
Gross wt.	537,800	509,300	571,000	591,000	583,000	577,000						561,517
Net wt.	259,800	259,800	259,800	259,800	259,800	259,800						259,800
Payload	278,000	249,500	311,200	331,200	323,200	317,200						301,717
TONS	139.00	124.75	155.60	165.60	161.60	158.60						150.86
B.C.M	49.64	44.56	55.57	59.14	57.72	56.64						53.88
Passes	4	4	4	4	4	4						4
Obdas weight	169.9	152.4	163.0	185.0	170.2	166.7						167.9

C14

LOADER# 6003
SIZE 30yd
MATERAL WASTE

LOADED WEIGHTS
lbs

JAN 13,1987
SHIFT C
UNIT 6120
MODEL 317ED-R170

Run Number	1	2	3	4	5	6	7	8	9	10	11	AVERAGE
Fr. axle wt.	193,600	198,000	206,000	184,600	218,000	197,000						199,533
Dr. axle wt.	368,000	314,000	342,000	327,000	366,000	359,000						346,000
Gross wt.	561,600	512,000	548,000	511,600	584,000	556,000						545,533
Net wt.	272,300	272,300	272,300	272,300	272,300	272,300						272,300
Payload	289,300	239,700	275,700	239,300	311,700	283,700						273,233
TONS	144.65	119.85	137.85	119.65	155.85	141.85						136.62
B.C.M	51.66	42.81	49.23	42.73	55.66	50.66						48.79
Passes	3	4	5	4	4	4						4

LOADER# 6003
SIZE 30yd
MATERAL WASTE

LOADED WEIGHTS
lbs

JAN 14,1987
SHIFT C
UNIT 6126
MODEL 317ED-R170

Run Number	1	2	3	4	5	6	7	8	9	10	11	AVERAGE
Fr. axle wt.	181,900	178,500	211,000	199,000	189,800							192,040
Dr. axle wt.	397,000	334,000	376,000	372,000	386,000							373,000
Gross wt.	578,900	512,500	587,000	571,000	575,800							565,040
Net wt.	262,400	262,400	262,400	262,400	262,400							262,400
Payload	316,500	250,100	324,600	308,600	313,400							302,640
TONS	158.25	125.05	162.30	154.30	156.70							151.32
B.C.M	56.52	44.66	57.97	55.11	55.97							54.04
Passes	4	4	4	4	4							4
Obdas Weight	165.3	149.0	169.8	175.5	167.0							165.3
Obdas Lights	* 0 0	0 0 *	0 0 *	0 * 0	0 * 0							
	0	0	*	*	0							
	*	0	0	0	*							
	0	0	0	0	0							
	0	*	0	0	0							
	0	0	0	0	0							

C15

LOADER# 6003
SIZE 30yd
MATERAL WASTE

LOADED WEIGHTS
lbs

JAN 14,1987
SHIFT C
UNIT 6124
MODEL 317ED-R170

Run Number	1	2	3	4	5	6	7	8	9	10	11	AVERAGE
Fr. axle wt.	201,000	180,900	204,000	194,500	209,000	194,600						197,333
Dr. axle wt.	383,000	339,000	371,000	353,000	390,000	355,000						365,167
Gross wt.	584,000	519,900	575,000	547,500	599,000	549,600						562,500
Net wt.	247,900	247,900	247,900	247,900	247,900	247,900						247,900
Payload	336,100	272,000	327,100	299,600	351,100	301,700						314,600
TONS	168.05	136.00	163.55	149.80	175.55	150.85						157.30
B.C.M	60.02	48.57	58.41	53.50	62.70	53.88						56.18
Passes	4	4	4	4	4	4						4

LOADER# 6003
SIZE 30yd
MATERAL WASTE

LOADED WEIGHTS
lbs

JAN 14,1987
SHIFT C
UNIT 6123
MODEL 317ED-R170

Run Number	1	2	3	4	5	6	7	8	9	10	11	AVERAGE
Fr. axle wt.	186,800	191,600	192,500	197,000	204,000	189,300	192,100					193,329
Dr. axle wt.	345,000	356,000	345,000	361,000	378,000	338,000	361,000					354,857
Gross wt.	531,800	547,600	537,500	558,000	582,000	527,300	553,100					548,186
Net wt.	253,900	253,900	253,900	253,900	253,900	253,900	253,900					253,900
Payload	277,900	293,700	283,600	304,100	328,100	273,400	299,200					294,286
TONS	138.95	146.85	141.80	152.05	164.05	136.70	149.60					147.14
B.C.M	49.63	52.45	50.64	54.31	58.59	48.82	53.43					52.55
Passes	4	4	4	4	4	4	4					4

LOADER# 6003
SIZE 30yd
MATERAL WASTE

LOADED WEIGHTS
lbs

JAN 16,1987
SHIFT A
UNIT 6127
MODEL 317ED-R170

Run Number	1	2	3	4	5	6	7	8	9	10	11	AVERAGE
Fr. axle wt.	209,000	204,000	216,000	210,000	189,400	220,000	210,000	216,000	264,000	224,000	214,000	216,036
Dr. axle wt.	341,000	352,000	352,000	362,000	358,000	368,000	347,000	335,000	365,000	357,000	344,000	352,818
Gross wt.	550,000	556,000	568,000	572,000	547,400	588,000	557,000	551,000	629,000	581,000	558,000	568,855
Net wt.	260,300	260,300	260,300	260,300	260,300	260,300	260,300	260,300	260,300	260,300	260,300	260,300
Payload	289,700	295,700	307,700	311,700	287,100	327,700	296,700	290,700	368,700	320,700	297,700	308,555
TONS	144.85	147.85	153.85	155.85	143.55	163.85	148.35	145.35	184.35	160.35	148.85	154.28
B.C.M	51.73	52.81	54.95	55.66	51.27	58.52	52.98	51.91	65.84	57.27	53.16	55.10
Passes	4	4	4	4	4	4	4	4	4	4	4	4
Obdas Weight	170.2	177.5	167.9	164.1	163.7	165.7	156.5	158.2	135.8	176.6	165.9	163.8
Obdas Lights	# 0 0	# 0 0	# 0 0	# 0 0	# 0 0	# 0 0	# 0 0	# 0 0	# 0 0	# 0 0	# 0 0	
	#	#	0	0	0	0	0	0	0	#	0	
	0	0	#	#	#	0	0	0	0	0	0	
	0	0	0	0	0	#	0	0	0	0	#	
	0	0	0	0	0	0	0	0	0	0	0	
	0	0	0	0	0	0	#	#	#	0	0	

IZE 30yd
ATERAL WASTE

LOADED WEIGHTS
lbs

SHIFT A
UNIT 6122
MODEL 317ED-R170

Run Number	1	2	3	4	5	6	7	8	9	10	11	AVERAGE
r. axle wt.	206,000	197,000	204,000	223,000	195,000	202,000	224,000	206,000	203,000	202,000	220,000	207,455
r. axle wt.	349,000	343,000	343,000	360,000	317,000	357,000	334,000	366,000	328,000	331,000	356,000	344,000
Gross wt.	555,000	540,000	547,000	583,000	512,000	559,000	558,000	572,000	531,000	533,000	576,000	551,455
Net wt.	255,400	255,400	255,400	255,400	255,400	255,400	255,400	255,400	255,400	255,400	255,400	255,400
Payload	299,600	284,600	291,600	327,600	256,600	303,600	302,600	316,600	275,600	277,600	320,600	296,055
TONS	149.80	142.30	145.80	163.80	128.30	151.80	151.30	158.30	137.80	138.80	160.30	148.03
B.C.M	53.50	50.82	52.07	58.50	45.82	54.22	54.04	56.54	49.22	49.57	57.25	52.87
Passes	4	4	4	4	4	4	4	4	4	4	4	4

DADER# 6003
IZE 30yd
ATERAL WASTE

LOADED WEIGHTS
lbs

JAN 16,1987
SHIFT A
UNIT 6120
MODEL 317ED-R170

Run Number	1	2	3	4	5	6	7	8	9	10	11	AVERAGE
r. axle wt.	203,000	190,000	214,000	216,000	206,000	210,000	206,000					206,429
r. axle wt.	354,000	339,000	365,000	363,000	346,000	355,000	359,000					354,429
Gross wt.	557,000	529,000	579,000	579,000	552,000	565,000	565,000					560,857
Net wt.	254,000	254,000	254,000	254,000	254,000	254,000	254,000					254,000
Payload	303,000	275,000	325,000	325,000	298,000	311,000	311,000					306,857
TONS	151.50	137.50	162.50	162.50	149.00	155.50	155.50					153.43
B.C.M	54.11	49.11	58.04	58.04	53.22	55.54	55.54					54.80
Passes	4	4	4	4	4	4	4					4

LOADER# 6003
SIZE 30yd
MATERAL WASTE

LOADED WEIGHTS
lbs

JAN 19,1987
SHIFT D
UNIT 6124
MODEL 317ED-R170

Run Number	1	2	3	4	5	6	7	8	9	10	11	AVERAGE
Fr. axle wt.	202,000	188,000	192,800	210,000	198,000	206,000	197,000	191,600				198,175
Dr. axle wt.	331,000	344,000	330,000	289,000	348,000	339,000	312,000	329,000				327,750
Gross wt.	533,000	532,000	522,800	499,000	546,000	545,000	509,000	520,600				525,925
Net wt.	264,600	264,600	264,600	264,600	264,600	264,600	264,600	264,600				264,600
Payload	268,400	267,400	258,200	234,400	281,400	280,400	244,400	256,000				261,325
TONS	134.20	133.70	129.10	117.20	140.70	140.20	122.20	128.00				130.66
B.C.M	47.93	47.75	46.11	41.86	50.25	50.07	43.64	45.72				46.67
Passes	4	4	4	4	4	4	4	4				4

LOADER# 6003
SIZE 30yd
MATERAL WASTE

LOADED WEIGHTS
lbs

JAN 19,1987
SHIFT D
UNIT 6125
MODEL 317ED-R170

Run Number	1	2	3	4	5	6	7	8	9	10	11	AVERAGE
Fr. axle wt.	184,000	194,000	202,000	206,000								196,500
Dr. axle wt.	311,000	306,000	314,000	319,000								312,500
Gross wt.	495,000	500,000	516,000	525,000								509,000
Net wt.	272,600	272,600	272,600	272,600								272,600
Payload	222,400	227,400	243,400	252,400								236,400
TONS	111.20	113.70	121.70	126.20								118.20
B.C.M	39.72	40.61	43.47	45.07								42.22
Passes	4	4	4	4								4

LOADER# 6003
SIZE 30yd
MATERAL WASTE

LOADED WEIGHTS
lbs

JAN 19,1987
SHIFT D
UNIT 6126
MODEL 317ED-R170

Run Number	1	2	3	4	5	6	7	8	9	10	11	AVERAGE
Fr. axle wt.	214,000	182,200	199,000	184,300	208,000							197,500
Dr. axle wt.	308,000	340,000	302,000	327,000	327,000							320,800
Gross wt.	522,000	522,200	501,000	511,300	535,000							518,300
Net wt.	255,700	255,700	255,700	255,700	255,700							255,700
Payload	266,300	266,500	245,300	255,600	279,300							262,800
TONS	133.15	133.25	122.65	127.80	139.65							131.30
B.C.M	47.56	47.59	43.81	45.64	49.88							46.89
Passes	4	4	4	4	4							4
Obdes Weight	56.9	101.6	111.0	111.7	48.1							85.9
Obdes Lights	0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0							

C20

LOADER# 6003
SIZE 30wd
MATERAL WASTE (footwall)

LOADED WEIGHTS
lbs

JAN 20,1987
SHIFT D
UNIT 6127
MODEL 317ED-R170

Run Number	1	2	3	4	5	6	7	8	9	10	11	AVERAGE
Fr. axle wt.	200,000	190,700	185,200	189,200	189,400	186,400	183,100	177,700	209,000	197,000	179,400	189,736
Dr. axle wt.	353,000	285,000	301,000	277,000	326,000	315,000	334,000	324,000	358,000	331,000	300,000	318,545
Gross wt.	553,000	475,700	486,200	466,200	515,400	501,400	517,100	501,700	567,000	528,000	479,400	508,282
Net wt.	252,200	252,200	252,200	252,200	252,200	252,200	252,200	252,200	252,200	252,200	252,200	252,200
Payload	300,800	223,500	234,000	214,000	263,200	249,200	264,900	249,500	314,800	275,800	227,200	256,082
TONS	150.40	111.75	117.00	107.00	131.60	124.60	132.45	124.75	157.40	137.90	113.60	128.04
B.C.M	53.72	39.91	41.79	38.22	47.00	44.50	47.31	44.56	56.22	49.25	40.57	45.73
Passes	4	4	4	4	4	4	4	4	4	4	4	4
Obdas Weight	161.5	126.5	121.6	119.1	139.3	129.4	137.0	134.3	151.4	142.3	123.7	135.1
Obdas Lights	# 0 0	# 0 0	# 0 0	# 0 0	# 0 0	# 0 0	# 0 0	# 0 0	# 0 0	# 0 0	# 0 0	
	0	0	0	0	0	0	0	0	0	0	0	
	0	0	0	0	0	0	0	0	0	0	0	
	#	0	0	0	0	0	0	0	0	0	0	
	0	0	0	0	#	0	0	0	0	0	0	
	0	#	#	#	0	#	#	#	#	#	#	

LOADER# 6003
SIZE 30ud
MATERAL WASTE (footwall)

LOADED WEIGHTS
lbs

JAN 20,1987
SHIFT D
UNIT 6121
MODEL 317ED-R170

Run Number	1	2	3	4	5	6	7	8	9	10	11	AVERAGE
Fr. axle wt.	194,500	201,000	202,000	180,300	190,800	190,300	188,500	187,900	193,200	208,000	185,900	192,945
Dr. axle wt.	338,000	300,000	314,000	272,000	317,000	306,000	315,000	276,000	288,000	357,000	286,000	306,273
Gross wt.	532,500	501,000	516,000	452,300	507,800	496,300	503,500	463,900	481,200	565,000	471,900	499,218
Net wt.	248,800	248,800	248,800	248,800	248,800	248,800	248,800	248,800	248,800	248,800	248,800	248,800
Payload	283,700	252,200	267,200	203,500	259,000	247,500	254,700	215,100	232,400	316,200	223,100	250,418
TONS	141.85	126.10	133.60	101.75	129.50	123.75	127.35	107.55	116.20	158.10	111.55	125.21
B.C.M	50.66	45.04	47.72	36.34	46.25	44.20	45.48	38.41	41.50	56.47	39.84	44.72
Passes	4	4	4	4	4	4	4	4	4	4	4	4

LOADER# 6003
SIZE 30ud
MATERAL WASTE (footwall)

LOADED WEIGHTS
lbs

JAN 20,1987
SHIFT D
UNIT 6122
MODEL 317ED-R170

C22

Run Number	1	2	3	4	5	6	7	8	9	10	11	AVERAGE
Fr. axle wt.	199,000	196,000	190,800	207,000	208,000	183,400	199,000	189,700	180,800	187,100	191,100	193,791
Dr. axle wt.	295,000	316,000	287,000	293,000	318,000	358,000	312,000	335,000	289,000	287,000	311,000	309,182
Gross wt.	494,000	512,000	477,800	500,000	526,000	541,400	511,000	524,700	469,800	474,100	502,100	502,973
Net wt.	253,600	253,600	253,600	253,600	253,600	253,600	253,600	253,600	253,600	253,600	253,600	253,600
Payload	240,400	258,400	224,200	246,400	272,400	287,800	257,400	271,100	216,000	220,500	248,500	249,373
TONS	120.20	129.20	112.10	123.20	136.20	143.90	128.70	135.55	108.00	110.25	124.25	124.69
B.C.M	42.93	46.14	40.04	44.00	48.64	51.39	45.97	48.41	38.57	39.38	44.38	44.53
Passes	4	4	4	4	4	4	4	4	4	4	4	4

LOADER# 6003
SIZE 30wd
MATERAL WASTE (footwall)

LOADED WEIGHTS
lbs

JAN 20,1987
SHIFT D
UNIT 6127
MODEL 317ED-R170

Run Number	1	2	3	4	5	6	7	8	9	10	11	AVERAGE
Fr. axle wt.	215,000	225,000	189,600	197,000								206,650
Br. axle wt.	355,000	338,000	329,000	317,000								334,750
Gross wt.	570,000	563,000	518,600	514,000								541,400
Net wt.	246,600	246,600	246,600	246,600								246,600
Payload	323,400	316,400	272,000	267,400								294,800
TONS	161.70	158.20	136.00	133.70								147.40
B.C.M	57.75	56.50	48.57	47.75								52.64
Passes	4	4	4	4								4
Obdas Weight	164.6	165.9	136.6	129.3								149.1
Obdas Lights	# 0 0 0 # 0 0 0	# 0 0 0 # 0 0 0	# 0 0 0 0 0 # 0	# 0 0 0 0 0 0 #								

C23

LOADER# 6003
SIZE 30yd
MATERAL WASTE (footwall)

LOADED WEIGHTS
lbs

JAN 20,1987
SHIFT D
UNIT 6127
MODEL 317ED-R170

Run Number	1	2	3	4	5	6	7	8	9	10	11	AVERAGE
Fr. axle wt.	197,000	181,600	191,500	189,400	205,000							192,900
Dr. axle wt.	296,000	275,000	327,000	335,000	326,000							311,800
Gross wt.	493,000	456,600	518,500	524,400	531,000							504,700
Net wt.	255,700	255,700	255,700	255,700	255,700							255,700
Payload	237,300	200,900	262,800	268,700	275,300							249,000
TONS	118.65	100.45	131.40	134.35	137.65							124.50
B.C.M	42.38	35.88	46.93	47.98	49.16							44.47
Passes	4	4	4	4	4							4

LOADER# 6003
SIZE 30yd
MATERAL WASTE (footwall)

LOADED WEIGHTS
lbs

JAN 29,1987
SHIFT C
UNIT 6126
MODEL 317ED-R170

Run Number	1	2	3	4	5	6	7	8	9	10	11	AVERAGE
Fr. axle wt.	185,600	178,100	183,700	181,000	182,500	182,600	183,600	194,100	176,100	185,200		181,250
Dr. axle wt.	378,000	364,000	353,000	364,000	347,000	374,000	363,000	380,100	351,000	329,000		360,310
Gross wt.	563,600	542,100	536,700	545,000	529,500	556,600	546,600	574,200	527,100	494,200		541,560
Net wt.	247,200	247,200	247,200	247,200	247,200	247,200	247,200	247,200	247,200	247,200		247,200
Payload	316,400	294,900	289,500	297,800	282,300	309,400	299,400	327,000	279,900	247,000		294,360
TONS	158.20	147.45	144.75	148.90	141.15	154.70	149.70	163.50	139.95	123.50		147.18
B.C.M	56.50	52.66	51.70	53.18	50.41	55.25	53.47	58.39	49.98	44.11		52.57
Passes	5	5	5	5	5	5	5	5	5	5		5
Obdas Weight	179.8	164.6	172.9	172.0	165.0	174.0	168.0	181.3	152.3	169.0		169.9
Obdas Weight	0 0 ‡	0 ‡ 0	0 ‡ 0	0 ‡ 0	0 ‡ 0	0 ‡ 0	0 0 ‡	0 0 ‡	0 ‡ 0	0 ‡ 0		
	‡	0	‡	‡	0	‡	0	‡	0	0		
	0	‡	0	0	0	0	‡	0	0	‡		
	0	0	0	0	0	0	0	0	0	0		
	0	0	0	0	0	0	0	0	0	0		
	0	0	0	0	‡	0	0	0	‡	0		

LOADER# 6003
SIZE 30yd
MATERAL WASTE (footwall)

LOADED WEIGHTS
lbs

JAN [redacted]
SHIFT B
UNIT 6122
MODEL 317ED-R170

Run Number	1	2	3	4	5	6	7	8	9	10	11	AVERAGE
Fr. axle wt.	200,000	184,700	173,200	177,700	188,500	186,100	182,600	191,500	185,100	187,700	178,000	185,009
Dr. axle wt.	365,000	368,000	331,000	349,000	338,000	356,000	342,000	374,000	323,000	337,000	333,000	346,909
Gross wt.	565,000	552,700	504,200	526,700	526,500	542,100	524,600	565,500	508,100	524,700	511,000	531,918
Net wt.	239,800	239,800	239,800	239,800	239,800	239,800	239,800	239,800	239,800	239,800	239,800	239,800
Payload	325,200	312,900	264,400	286,900	286,700	302,300	284,800	325,700	268,300	284,900	271,200	292,118
TONS	162.60	156.45	132.20	143.45	143.35	151.15	142.40	162.85	134.15	142.45	135.60	146.06
B.C.M	58.07	55.88	47.22	51.23	51.20	53.98	50.86	58.16	47.91	50.88	48.43	52.17
Passes	5	5	5	5	5	5	5	5	5	5	5	5

LOADER# 6003
SIZE 30yd
MATERAL WASTE

LOADED WEIGHTS
STUDY AVERAGES
lbs

JAN 13:29:1987
MODEL 317ED-R170

C26

Study Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Fr. axle wt.	197,183	199,533	192,040	197,333	193,329	216,036	207,455	206,429	198,175	196,500	197,500	189,736	192,946	193,791	206,650	192,900	181,250	185,0
Dr. axle wt.	364,333	346,000	373,000	365,167	354,857	352,818	344,000	354,429	327,750	312,500	320,800	318,546	306,273	309,182	334,750	311,800	360,310	346,9
Gross wt.	561,517	545,533	565,040	562,500	548,186	568,855	551,455	560,857	525,925	509,000	518,300	508,282	499,218	502,973	541,400	504,700	541,560	531,9
Net wt.	259,800	272,300	262,400	247,900	253,900	260,300	255,400	254,000	264,600	272,600	255,700	252,200	248,800	253,600	246,600	255,700	247,200	239,8
Payload	301,717	273,233	302,640	314,600	294,286	308,555	296,055	306,857	261,325	236,400	262,600	256,082	250,418	249,373	294,800	249,000	294,360	292,1
TONS	150.86	136.62	151.32	157.30	147.14	154.28	148.03	153.43	130.66	118.20	131.30	128.04	125.21	124.69	147.40	124.50	147.18	146.
B.C.M	53.88	48.79	54.04	56.18	52.55	55.10	52.87	54.80	46.67	42.22	46.89	45.73	44.72	44.53	52.64	44.47	52.57	52.1
Passes	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5
Obdas Weight	167.9		165.3			163.8					85.9	135.1			149.1		169.9	

OVERALL STUDY AVERAGE

No. of Studies	18
Fr. axle wt.	196,877
Dr. axle wt.	339,079
Gross wt.	535,957
Net wt.	255,711
Payload	280,245
TONS	140.12
B.C.M	50.05
Passes	4.11
Obdas Weight	158.52

SEPTEMBER 1987 WEIGH STUDY

LOADER# 6003
SIZE 30yd
MATERAL WASTE

LOADED WEIGHTS
lbs

SEPT 21,22 1987
SHIFT A,B
UNIT 6122
MODEL 317ED-R170

Run Number	1	2	3	4	5	6	7	8	9	10	11	AVERAGE
Fr. axle wt.	247,300	211,100	243,000	245,700	212,200	206,200	210,800	215,500	224,600			224,044
Dr. axle wt.	411,800	420,900	429,600	423,500	389,200	392,900	372,500	407,500	450,300			410,911
Gross wt.	659,100	632,000	672,600	669,200	601,400	599,100	583,300	623,000	674,900			634,956
Net wt.	272,000	272,000	272,000	272,000	272,000	272,000	272,000	272,000	272,000			272,000
Payload	387,100	360,000	400,600	397,200	329,400	327,100	311,300	351,000	402,900			362,956
TONS	193.55	180.00	200.30	198.60	164.70	163.55	155.65	175.50	201.45			181.48
B.C.M	69.13	64.29	71.54	70.93	58.82	58.41	55.59	62.68	71.95			64.82
Passes	4	4	4	4	4	4	4	4	4			4

LOADER# 6003
SIZE 30yd
MATERAL WASTE

LOADED WEIGHTS
lbs

SEPT 21,22 1987
SHIFT A,B
UNIT 6127
MODEL 317ED-R170

Run Number	1	2	3	4	5	6	7	8	9	10	11	AVERAGE
Fr. axle wt.	225,400	266,100	241,900	224,200	251,400	226,700	209,200	204,400	213,000	207,200		226,950
Dr. axle wt.	401,700	424,400	474,200	397,300	380,900	451,200	412,900	384,200	426,300	466,400		421,950
Gross wt.	627,100	690,500	716,100	621,500	632,300	677,900	622,100	588,600	639,300	673,600		648,900
Net wt.	271,450	271,450	271,450	271,450	271,450	271,450	271,450	271,450	271,450	271,450		271,450
Payload	355,650	419,050	444,650	350,050	360,850	406,450	350,650	317,150	367,850	402,150		377,450
TONS	177.83	209.53	222.33	175.03	180.43	203.23	175.33	158.58	183.93	201.08		188.73
B.C.M	63.51	74.83	79.40	62.51	64.44	72.58	62.62	56.64	65.69	71.82		67.40
Passes	4	4	4	4	4	4	4	4	4	4		4
Obdas Weight	189.5	179.0	227.6	189.6	206.7	192.6	169.0	150.9	174.8	184.6		186.4
Obdas Lights	0 0 ‡ ‡ 0 0 0 0	0 ‡ 0 0 0 0 0 ‡	0 0 ‡ ‡ 0 0 0 0	0 0 ‡ 0 ‡ 0 0 0	0 0 ‡ ‡ 0 0 0 0	0 0 ‡ ‡ 0 0 0 0	0 0 ‡ 0 ‡ 0 0 0	0 0 ‡ 0 0 0 ‡ 0	0 0 ‡ 0 ‡ 0 0 0	0 0 ‡ ‡ 0 0 0 0		

LOADER# 6003
SIZE 30yd
MATERAL WASTE

LOADED WEIGHTS
lbs

SEPT 21,22 1987
SHIFT A,B
UNIT 6126
MODEL 317ED-R170

Run Number	1	2	3	4	5	6	7	8	9	10	11	AVERAGE
Fr. axle wt.	240,000	214,300	207,900	211,200	210,800	201,400	219,300	198,800	236,200			215,544
Dr. axle wt.	408,100	402,200	381,900	386,100	455,000	408,700	445,400	381,300	397,700			407,378
Gross wt.	648,100	616,500	589,800	597,300	665,800	610,100	664,700	580,100	633,900			622,922
Net wt.	273,550	273,550	273,550	273,550	273,550	273,550	273,550	273,550	273,550			273,550
Payload	374,550	342,950	316,250	323,750	392,250	336,550	391,150	306,550	360,350			349,372
TONS	187.28	171.48	158.13	161.88	196.13	168.28	195.58	153.28	180.18			174.69
B.C.M	66.89	61.24	56.48	57.81	70.05	60.10	69.85	54.74	64.35			62.39
Passes	4	4	4	4	4	4	4	4	4			4
Obdas Weight	207.0	185.4	169.3	176.0	197.0	175.6	200.0	164.3	200.4			186.1
Obdas Lights	* 0 0 * 0 0 0 0	* 0 0 * 0 0 0 *	* 0 0 0 * 0 0 0	0 0 * * 0 0 0 0	* 0 0 * 0 0 0 0	0 * 0 * 0 0 0 0	* 0 0 * 0 0 0 0	0 * 0 0 * 0 0 0	* 0 0 * 0 0 0 0			

LOADER# 6003
SIZE 30yd
MATERAL WASTE

LOADED WEIGHTS
lbs

SEPT 22,1987
SHIFT B
UNIT 6123
MODEL 317ED-R170

Run Number	1	2	3	4	5	6	7	8	9	10	11	AVERAGE
Fr. axle wt.	199,200	198,200	224,900	214,700	210,300	242,700	217,300					215,329
Dr. axle wt.	382,500	356,200	422,200	410,200	371,900	379,900	431,600					393,500
Gross wt.	581,700	554,400	647,100	624,900	582,200	622,600	648,900					608,829
Net wt.	268,800	268,800	268,800	268,800	268,800	268,800	268,800					268,800
Payload	312,900	285,600	378,300	356,100	313,400	353,800	380,100					340,029
TONS	156.45	142.80	189.15	178.05	156.70	176.90	190.05					170.01
B.C.M	55.88	51.00	67.56	63.59	55.97	63.18	67.88					60.72
Passes	4	4	4	4	4	4	4					4

LOADER# 6003
SIZE 30yd
MATERAL WASTE

LOADED WEIGHTS
lbs

SEPT 22,1987
SHIFT B
UNIT 6124
MODEL 317ED-R170

Run Number	1	2	3	4	5	6	7	8	9	10	11	AVERAGE
Fr. axle wt.	212,900	231,200	225,500									223,200
Dr. axle wt.	356,600	370,000	400,500									375,700
Gross wt.	569,500	601,200	626,000									598,900
Net wt.	269,700	269,700	269,700									269,700
Payload	299,800	331,500	356,300									329,200
TONS	149.90	165.75	178.15									164.60
B.C.M	53.54	59.20	63.63									58.79
Passes	4	4	4									4

LOADER# 6001
SIZE 30yd
MATERAL WASTE

LOADED WEIGHTS
lbs

SEPT 22,23 1987
SHIFT B
UNIT 6125
MODEL 317ED-R170

Run Number	1	2	3	4	5	6	7	8	9	10	11	AVERAGE
Fr. axle wt.	205,600	213,600	210,400	224,100	211,100	222,900	218,000	227,300	207,900	220,100		216,100
Br. axle wt.	399,500	414,800	402,800	436,600	407,500	384,600	374,300	381,800	378,800	421,700		400,240
Gross wt.	605,100	628,400	613,200	660,700	618,600	607,500	592,300	609,100	586,700	641,800		616,340
Net wt.	269,200	269,200	269,200	269,200	269,200	269,200	269,200	269,200	269,200	269,200		269,200
Payload	335,900	359,200	344,000	391,500	349,400	338,300	323,100	339,900	317,500	372,600		347,140
TONS	167.95	179.60	172.00	195.75	174.70	169.15	161.55	169.95	158.75	186.30		173.57
B.C.M	59.98	64.15	61.43	69.91	62.40	60.41	57.70	60.70	56.70	66.54		61.99
Passes	4	4	4	4	4	4	4	4	4	4		4

LOADER# 6001
SIZE 30yd
MATERAL WASTE

LOADED WEIGHTS
lbs

SEPT 22,24 1987
SHIFT B-D
UNIT 6120
MODEL 317ED-R170

Run Number	1	2	3	4	5	6	7	8	9	10	11	AVERAGE
Fr. axle wt.	210,700	201,300	213,100	206,700	216,500	198,500	222,100	210,900				209,975
Br. axle wt.	413,800	397,400	378,100	394,500	435,200	416,100	357,200	377,100				396,175
Gross wt.	624,500	598,700	591,200	601,200	651,700	614,600	579,300	588,000				606,150
Net wt.	270,100	270,100	270,100	270,100	270,100	270,100	270,100	270,100				270,100
Payload	354,400	328,600	321,100	331,100	381,600	344,500	309,200	317,900				336,050
TONS	177.20	164.30	160.55	165.55	190.80	172.25	154.60	158.95				168.03
B.C.M	63.29	58.68	57.34	59.13	68.15	61.52	55.22	56.77				60.01
Passes	4	4	4	4	4	4	4	4				4

LOADER# 600J
SIZE 30yd
MATERAL WASTE

LOADED WEIGHTS
lbs

SEPT 22;24 1987
SHIFT B;D
UNIT 6127
MODEL 317ED-R170

Run Number	1	2	3	4	5	6	7	8	9	10	11	AVERAGE
Fr. axle wt.	210;500	219;200	212;600	217;900								215;050
Br. axle wt.	425;900	423;100	394;300	382;700								406;500
Gross wt.	636;400	642;300	606;900	600;600								621;550
Net wt.	271;450	271;450	271;450	271;450								271;450
Payload	364;950	370;850	335;450	329;150								350;100
TONS	182.48	185.43	167.73	164.58								175.05
B.C.N	65.17	66.23	59.90	58.78								62.52
Passes	4	4	4	4								4
Obdas Weight	177.7	185.7	174.9	178.4								179.2
Obdas Lights	0 0 8 8 0 0 0 8	0 0 8 8 0 0 0 8	0 0 8 0 0 0 0 8	0 0 0 0 0 0 0 0								

C34

LOADER# 6003
SIZE 30-yd
MATERAL WASTE

LOADED WEIGHTS
lbs

SEPT 24,25 1987
SHIFT B
UNIT 6126
MODEL 317ED-R170

Run Number	1	2	3	4	5	6	7	8	9	10	11	12	AVERAGE
Fr. axle wt.	211,500	197,900	202,300	215,900	215,300	211,100	213,500	198,200	195,300	226,200	190,300	191,800	205,775
Br. axle wt.	389,700	397,100	396,600	380,500	380,400	407,500	400,400	375,800	376,000	388,200	338,300	372,200	383,558
Gross wt.	601,200	595,000	598,900	596,400	595,700	618,600	613,900	574,000	571,300	614,400	528,600	564,000	589,333
Net wt.	273,550	273,550	273,550	273,550	273,550	273,550	273,550	273,550	273,550	273,550	273,550	273,550	273,550
Payload	327,650	321,450	325,350	322,850	322,150	345,050	340,350	300,450	297,750	340,850	255,050	290,450	315,783
TONS	163.83	160.73	162.68	161.43	161.08	172.53	170.18	150.23	148.88	170.43	127.53	145.23	157.8*
B.C.M	58.51	57.40	58.10	57.65	57.53	61.62	60.78	53.65	53.17	60.87	45.55	51.87	56.39
Passes	4	4	4	4	4	4	4	4	4	4	4	4	4
Obdas Weight	165.2	163.0	174.6	174.3	176.7	178.6	178.2	159.8	156.9	180.4	154.0	151.9	183.1
Obdas Lights	0 0 0 0 0 0 0 0	* 0 0 0 * 0 0 0	* 0 0 * 0 0 0 0	0 0 0 * 0 0 0 0	* 0 0 * 0 0 0 0	* 0 0 * 0 0 0 0	0 0 0 0 0 0 0 0	0 * 0 0 0 * 0 0	0 * 0 0 0 * 0 0	* 0 0 * 0 0 0 0	0 * 0 0 0 0 0 0	0 * 0 0 0 0 * 0	

C35

LOADER# 6003
SIZE 30yd
MATERAL WASTE

LOADED WEIGHTS
lbs

SEPT 24,1987
SHIFT D
UNIT 6121
MODEL 317ED-R170

Run Number	1	2	3	4	5	6	7	8	9	10	11	AVERAGE
Fr. axle wt.	215,400	215,100	209,900	200,300	201,100	199,700	208,300	201,500	202,900	201,500		205,570
Br. axle wt.	402,300	348,100	377,600	325,400	351,700	311,900	368,600	342,500	344,800	361,800		353,470
Gross wt.	617,700	563,200	587,500	525,700	552,800	511,600	576,900	544,000	547,700	563,300		559,040
Net wt.	273,250	273,250	273,250	273,250	273,250	273,250	273,250	273,250	273,250	273,250		273,250
Payload	344,450	289,950	314,250	252,450	279,550	238,350	303,650	270,750	274,450	290,050		285,790
TONS	172.23	144.98	157.13	126.23	139.78	119.18	151.83	135.38	137.23	145.03		142.90
B.C.M	61.51	51.78	56.12	45.08	49.92	42.56	54.23	48.35	49.01	51.80		51.04
Passes	4	4	4	4	4	4	4	4	4	4		4

LOADER# 6003
SIZE 30yd
MATERAL WASTE

LOADED WEIGHTS
STUDY AVERAGES
lbs

SEPT 21:25,1987
MODEL 317ED-R170

Study Number	1	2	3	4	5	6	7	8	9	10
Fr. axle wt.	224,044	226,950	215,544	215,329	223,200	216,100	209,975	215,050	205,775	205,570
Br. axle wt.	410,911	421,950	407,378	393,500	375,700	400,240	396,175	406,500	383,558	353,470
Gross wt.	634,955	648,900	622,922	608,829	598,900	616,340	606,150	621,550	589,333	559,040
Net wt.	272,000	271,450	273,550	268,800	269,700	269,200	270,100	271,450	273,550	273,250
Payload	362,955	377,450	349,372	340,029	329,200	347,140	336,050	350,100	315,783	285,790
TONS	181.48	188.73	174.69	170.01	164.60	173.57	168.03	175.05	157.89	142.90
B.C.M	64.82	67.40	62.39	60.72	58.79	61.99	60.01	62.52	56.39	51.04
Passes	4	4	4	4	4	4	4	4	4	4
Obdas Weight		186.4	186.1					179.2	167.8	

OVERALL STUDY AVERAGE

No. of Studies	10
Fr. axle wt.	215,754
Dr. axle wt.	394,938
Gross wt.	610,692
Net wt.	271,305
Payload	339,387
TDMS	169.69
B.C.M	60.61
Passes	4.00
Obdas Weight	179.38

APPENDIX D

Time Studies

I
FILE 8703171
CREW D

1987 TIME STUDIES
STUDY VS OBDAS
PH2800 LOADING 6127 TRUCK

HAUL STUDY(min.sec)											OBDAS (min.sec)									
WAIT AT SHOVEL	SPOT	NUMBER OF BUCKETS	AVE CYCLE TIME	TOTAL LOAD TIME	TRAVEL FULL	WAIT AT DUMP	SPOT	DUMP	TRAVEL EMPTY	TOTAL CYCLE TIME	WAIT AT SHOVEL	SPOT	LOAD TIME	TRAVEL FULL	WAIT AT DUMP	SPOT	DUMP	TRAVEL EMPTY	TOTAL CYCLE TIME	LOAD WEIGHT TONS
1.02	0.16	5	0.35	2.55	5.08	0.00	0.16	0.47	3.18	13.42	3.14	0.26	2.23	5.04	0.00	0.16	0.45	3.19	15.27	135.0
0.00	0.19	4	0.38	2.32	5.08	0.00	0.16	0.49	3.05	12.09	0.00	?	2.20	5.00	0.00	0.17	0.32	3.21	?	150.0
4.27	0.17	4	0.34	2.16	4.58	0.00	0.18	0.39	3.17	16.12	4.43	0.26	1.43	4.51	0.00	0.18	0.38	3.05	15.44	143.0
1.45	0.21	5	0.31	2.35	5.12	0.00	0.16	0.47	3.09	14.05	1.44	0.28	2.09	5.07	0.00	0.17	0.30	?	?	167.0
1.08	0.16	4	0.31	2.04	4.57	0.00	0.14	0.39	3.35	12.53	1.48	0.22	?	4.44	0.00	0.19	0.39	3.35	?	134.0
1.47	0.25	4	0.29	1.56	5.07	0.00	0.16	0.39	3.20	13.30	0.00	0.30	3.16	5.02	0.00	0.17	0.37	3.20	13.02	129.0
1.18	0.21	4	0.31	2.04	4.34	0.00	0.16	0.41	3.01	12.15	0.00	0.24	2.52	4.29	0.00	0.16	0.40	3.02	11.43	125.0
0.00	0.24	4	0.34	2.16	4.56	0.00	0.17	0.39	3.04	11.36	0.00	0.27	1.44	4.49	0.00	0.18	0.39	3.03	11.00	135.0
3.28	0.41	4	0.31	2.04	4.34	0.00	0.16	0.41	3.12	14.56	1.47	0.51	3.10	4.28	0.00	0.16	0.40	3.15	14.27	137.0
2.13	0.10	4	0.31	2.04	4.49	0.00	0.24	0.37	2.53	13.10	2.06	0.17	1.34	4.45	0.00	0.22	0.39	3.55	13.38	130.0

02

2
FILE 8703241
CREW B

1987 TIME STUDIES
STUDY VS OBDAS
PH2800 LOADING 6126 TRUCK

	HAUL STUDY(min.sec)										OBDAS (min.sec)									
WAIT AT SHOVEL	SPOT	NUMBER OF BUCKETS	AVE CYCLE TIME	TOTAL LOAD TIME	TRAVEL FULL	WAIT AT DUMP	SPOT	DUMP	TRAVEL EMPTY	TOTAL CYCLE TIME	WAIT AT SHOVEL	SPOT	LOAD TIME	TRAVEL FULL	WAIT AT DUMP	SPOT	DUMP	TRAVEL EMPTY	TOTAL CYCLE TIME	LOAD WEIGHT TONS
3.28	0.14	6	0.26	2.36	5.35	0.00	0.17	0.37	3.26	16.13	3.21	0.26	2.09	5.34	0.00	0.17	0.35	3.28	15.50	84.0
5.35	0.16	5	0.25	2.05	5.47	0.00	0.19	0.35	3.25	18.02	5.21	0.25	1.41	5.45	0.00	0.17	0.33	3.26	17.28	117.0
7.59	0.21	5	0.31	2.35	5.38	0.00	0.14	0.41	3.21	20.49	7.29	0.56	2.02	5.34	0.00	0.15	0.40	3.20	20.16	118.0
8.13	0.18	4	0.27	1.48	5.08	0.00	0.20	0.37	3.26	19.50	8.04	0.31	1.22	5.05	0.00	0.19	0.32	3.34	19.27	80.0
9.57	0.13	5	0.27	2.15	5.50	0.00	0.18	0.41	3.52	23.06	9.14	0.57	1.47	5.47	0.00	0.23	0.35	31.55	50.38	140.0
0.00	0.23	5	0.27	2.15	5.56	0.00	0.17	0.40	3.28	12.59	0.00	0.27	1.48	5.53	0.00	0.18	0.27	3.44	12.37	138.0

D3

3
FILE 8703251
CREW B

1987 TIME STUDIES
STUDY VS OBDAS
PH2800 LOADING 6127 TRUCK

	HAUL STUDY(min.sec)										OBDAS (min.sec)									
WAIT AT SHOVEL	SPOT	NUMBER OF BUCKETS	AVE CYCLE TIME	TOTAL LOAD TIME	TRAVEL FULL	WAIT AT DUMP	SPOT	DUMP	TRAVEL EMPTY	TOTAL CYCLE TIME	WAIT AT SHOVEL	SPOT	LOAD TIME	TRAVEL FULL	WAIT AT DUMP	SPOT	DUMP	TRAVEL EMPTY	TOTAL CYCLE TIME	LOAD WEIGHT TONS
0.38	0.28	4	0.22	1.28	5.14	0.00	0.19	0.39	3.47	12.33	0.32	0.33	1.11	5.08	0.00	0.19	0.37	3.46	12.06	123.0
7.31	0.27	4	0.23	1.32	5.55	0.00	0.19	0.37	3.06	19.27	7.30	0.30	1.13	6.11	0.00	0.18	0.37	4.06	20.25	119.0
0.00	0.27	5	0.27	2.15	5.31	0.00	0.26	0.38	4.03	13.20	0.00	0.31	1.50	5.26	0.00	0.26	0.38	4.01	12.52	152.0
4.25	0.16	4	0.24	1.36	5.37	0.00	0.16	0.49	4.11	17.10	4.47	0.24	1.13	5.33	0.00	0.15	0.31	4.24	17.07	144.0
1.30	0.25	4	0.27	1.48	5.34	0.00	0.19	0.38	3.46	13.60	1.30	0.30	1.24	5.30	0.00	0.20	0.37	3.47	13.38	134.0
5.31	0.20	4	0.28	1.52	5.29	0.00	0.22	0.40	3.44	17.58	5.26	0.26	1.25	5.25	0.00	0.23	0.38	3.44	17.27	133.0

4
FILE 8704011
CREW B

1987 TIME STUDIES
STUDY VS OBDAS
PH2800 LOADING 6126 truck

HAUL STUDY(min.sec)											OBDAS (min.sec)									
WAIT AT SHOVEL	SPOT	NUMBER OF BUCKETS	AVE CYCLE TIME	TOTAL LOAD TIME	TRAVEL FULL	WAIT AT DUMP	SPOT	DUMP	TRAVEL EMPTY	TOTAL CYCLE TIME	WAIT AT SHOVEL	SPOT	LOAD TIME	TRAVEL FULL	WAIT AT DUMP	SPOT	DUMP	TRAVEL EMPTY	TOTAL CYCLE TIME	LOAD WEIGHT TONS
0.00	0.13	4	0.24	1.36	6.42	0.00	0.16	0.42	4.32	14.01	0.00	0.19	1.11	6.40	0.00	0.14	0.43	4.33	13.40	115.0
0.00	0.15	4	0.25	1.40	6.46	0.00	0.20	0.43	4.20	14.04	0.00	0.17	1.15	6.45	0.00	0.19	0.44	4.20	13.40	106.0
0.00	0.15	5	0.25	2.05	6.53	19.29	0.21	0.46	4.34	34.23	0.00	0.17	1.37	7.08	18.29	1.06	0.45	4.35	33.57	140.0
5.33	0.30	5	0.22	1.50	6.19	0.00	0.17	0.42	4.22	19.33	5.26	0.40	1.27	6.18	0.00	0.15	0.42	4.23	19.11	147.0
0.00	0.13	5	0.28	2.20	6.25	0.00	0.17	0.41	4.44	14.40	0.00	0.14	1.52	6.25	0.00	0.16	0.41	19.02	28.30	138.0
2.18	0.38	4	0.24	1.36	6.04	0.00	0.20	0.45	4.12	15.53	0.18	0.47	2.34	6.03	0.00	0.17	0.45	4.15	14.59	94.0
0.41	0.20	5	0.23	1.55	6.52	0.00	0.17	0.46	4.14	15.05	0.00	0.22	2.22	6.41	0.00	0.16	0.44	4.16	14.41	139.0
1.41	0.13	4	0.31	2.04	6.01	0.00	0.17	0.46	4.25	15.27	1.07	1.01	1.30	5.59	0.00	0.16	0.47	4.34	15.14	113.0
2.53	0.21	5	0.26	2.10	6.25	0.00	0.20	0.40	4.51	17.40	2.32	0.34	1.44	6.25	0.00	0.17	0.42	4.51	17.05	115.0
1.31	0.20	4	0.25	1.40	6.31	0.00	0.20	0.40	3.58	15.00	1.04	0.38	1.16	6.27	0.00	0.18	0.41	4.05	14.29	131.0

D4

5
FILE 8704021
CREW B

1987 TIME STUDIES
STUDY VS OBDAS
PH2800 LOADING 6127 truck

HAUL STUDY(min.sec)											OBDAS (min.sec)									
WAIT AT SHOVEL	SPOT	NUMBER OF BUCKETS	AVE CYCLE TIME	TOTAL LOAD TIME	TRAVEL FULL	WAIT AT DUMP	SPOT	DUMP	TRAVEL EMPTY	TOTAL CYCLE TIME	WAIT AT SHOVEL	SPOT	LOAD TIME	TRAVEL FULL	WAIT AT DUMP	SPOT	DUMP	TRAVEL EMPTY	TOTAL CYCLE TIME	LOAD WEIGHT TONS
1.24	0.25	4	0.28	1.52	4.47	0.00	0.28	0.41	3.45	13.22	1.19	0.33	1.24	4.45	0.00	0.27	0.41	3.43	12.52	137.0
1.27	0.25	4	0.26	1.44	5.05	0.00	0.20	0.44	3.14	12.59	1.24	0.33	1.19	5.03	0.00	0.21	0.45	3.14	12.39	153.0
0.00	0.16	4	0.30	2.00	4.40	0.00	0.30	0.44	3.19	11.29	0.00	0.17	1.28	4.41	0.00	0.28	0.47	3.17	10.58	136.0

6
FILE 8704022
CREW B

1987 TIME STUDIES
STUDY VS OBDAS
PH2800 LOADING 6127 truck

HAUL STUDY(min.sec)											OBDAS (min.sec)									
WAIT AT SHOVEL	SPOT	NUMBER OF BUCKETS	AVE CYCLE TIME	TOTAL LOAD TIME	TRAVEL FULL	WAIT AT DUMP	SPOT	DUMP	TRAVEL EMPTY	TOTAL CYCLE TIME	WAIT AT SHOVEL	SPOT	LOAD TIME	TRAVEL FULL	WAIT AT DUMP	SPOT	DUMP	TRAVEL EMPTY	TOTAL CYCLE TIME	LOAD WEIGHT TONS
2.06	0.20	4	0.31	2.04	5.46	0.00	0.21	0.39	4.10	15.26	1.57	0.29	1.35	5.41	0.00	0.20	0.40	4.09	14.51	176.0
1.53	0.18	4	0.30	2.00	5.59	0.00	0.25	0.40	3.34	14.49	0.41	0.24	2.40	5.55	0.00	0.24	0.42	3.34	14.20	164.0
4.29	0.30	4	0.34	2.16	6.04	0.00	0.22	0.40	3.39	18.00	2.40	1.37	1.25	5.58	0.00	0.19	0.40	3.40	16.19	158.0

7
FILE 8704031
CREW C

1987 TIME STUDIES
STUDY VS OBDAS
01 DEMAG LOADING 6126 TRUCK

HAUL STUDY(min.sec)											OBDAS (min.sec)									
WAIT AT SHOVEL	SPOT	NUMBER OF BUCKETS	AVE CYCLE TIME	TOTAL LOAD TIME	TRAVEL FULL	WAIT AT DUMP	SPOT	DUMP	TRAVEL EMPTY	TOTAL CYCLE TIME	WAIT AT SHOVEL	SPOT	LOAD TIME	TRAVEL FULL	WAIT AT DUMP	SPOT	DUMP	TRAVEL EMPTY	TOTAL CYCLE TIME	LOAD WEIGHT TONS
0.32	0.17	7	0.33	3.51	3.48	0.37	1.41	0.51	2.50	14.27	0.18	0.24	3.19	4.59	0.00	1.03	0.27	3.38	14.08	126.0
0.11	0.32	7	0.31	3.37	3.43	0.00	0.51	0.53	2.48	12.35	0.03	0.19	3.06	3.37	0.00	0.50	0.29	3.14	11.38	125.0
0.00	0.15	8	0.30	4.00	3.44	0.00	0.19	0.52	2.49	11.59	0.00	0.17	3.27	3.43	0.00	0.18	0.46	2.55	11.26	138.0
1.42	0.00	8	0.32	4.16	3.51	0.00	0.20	0.46	3.42	14.45	1.11	0.43	3.46	3.44	0.00	0.20	0.43	3.45	14.12	131.0
0.00	0.23	8	0.32	4.16	3.46	0.00	0.14	0.45	3.01	12.25	0.00	0.28	3.41	3.39	0.00	0.17	0.35	3.12	11.52	116.0
7.01	0.37	9	0.33	4.57	3.53	0.00	0.25	0.48	2.57	20.38	6.50	0.49	4.23	3.49	0.00	0.24	0.51	3.59	21.05	141.0
0.52	0.35	8	0.35	4.40	4.13	0.00	0.22	0.47	3.01	14.30	0.00	0.28	4.07	4.08	0.00	0.24	0.39	3.16	13.02	120.0

8
FILE H704071
CREW B

1987 TIME STUDIES
STUDY VS OBDAS
01 DEMAG LOADING 6127 TRUCK

HAUL STUDY(min.sec)										OBDAS (min.sec)									
WAIT AT SHOVEL	SPOT	NUMBER OF BUCKETS	AVE CYCLE TIME	TOTAL LOAD TIME	TRAVEL FULL	WAIT AT DUMP	SPOT	DUMP	TRAVEL EMPTY	TOTAL CYCLE TIME	WAIT AT SHOVEL	SPOT	LOAD TIME	TRAVEL FULL	WAIT AT DUMP	SPOT	DUMP	TRAVEL EMPTY	TOTAL CYCLE TIME	LOAD WEIGHT TONS
2.11	0.19	9	0.37	5.33	4.36	0.00	0.23	0.46	3.02	16.50	2.09	0.21	4.59	4.30	0.00	0.25	0.28	3.22	16.14	155.0
5.32	0.13	9	0.49	7.21	4.28	0.00	0.22	0.57	3.18	22.11	5.25	0.20	6.35	4.23	0.00	0.26	0.54	23.46	41.49	171.0
8.43	0.23	9	0.32	4.48	4.52	0.00	0.23	0.48	3.02	22.59	3.24	0.32	4.19	4.50	0.00	0.30	0.34	3.17	17.26	122.0
2.08	0.23	9	0.35	5.15	4.47	0.00	0.23	0.58	2.52	16.46	1.58	0.37	4.34	4.45	0.00	0.23	0.35	3.15	16.07	175.0
0.00	0.17	9	0.34	5.06	4.45	0.00	0.28	1.04	3.13	14.53	0.00	0.22	4.24	4.42	0.00	0.29	2.14	2.56	15.07	177.0
4.34	0.23	8	0.34	4.32	5.32	0.00	0.25	0.50	2.50	19.06	3.34	0.33	4.26	4.56	0.00	0.26	0.30	3.12	17.37	161.0

9
FILE 8704091
CREW B

1987 TIME STUDIES
STUDY VS OBDAS
PH2800 LOADING 6127 TRUCK

HAUL STUDY(min.sec)										OBDAS (min.sec)									
WAIT AT SHOVEL	SPOT	NUMBER OF BUCKETS	AVE CYCLE TIME	TOTAL LOAD TIME	TRAVEL FULL	WAIT AT DUMP	SPOT	DUMP	TRAVEL EMPTY	TOTAL CYCLE TIME	WAIT AT SHOVEL	SPOT	LOAD TIME	TRAVEL FULL	WAIT AT DUMP	SPOT	DUMP	TRAVEL EMPTY	TOTAL CYCLE TIME	LOAD WEIGHT TONS
0.00	0.32	4	0.31	2.04	6.42	0.23	0.28	0.47	4.09	15.05	0.00	0.33	1.32	6.43	0.00	0.47	0.31	4.26	14.32	139.0
0.00	0.31	4	0.25	1.40	6.46	3.38	0.31	0.57	3.56	17.59	0.00	0.32	1.19	6.33	3.38	0.37	0.34	4.20	17.33	155.0
0.24	0.17	4	0.24	1.36	6.23	1.01	0.37	0.48	4.23	15.29	0.20	0.22	1.13	6.20	0.56	0.40	0.33	4.40	15.04	156.0
0.00	0.17	4	0.25	1.40	6.25	0.25	1.17	0.56	3.56	14.56	0.00	0.19	1.15	6.23	1.15	0.26	0.47	4.06	14.31	168.0
0.00	0.25	3	0.26	1.18	6.05	1.35	0.43	0.57	3.56	14.59	0.00	0.27	0.56	5.58	1.04	1.12	0.30	4.43	14.50	140.0
0.00	0.38	5	0.29	2.25	6.46	3.24	0.33	0.53	3.34	18.13	0.00	0.28	1.54	6.46	3.16	0.40	0.29	3.57	17.30	174.0

APPENDIX E

Haul Cycle Simulations

The following haul cycle simulations for haul time empty and haul time full were generated using minesite software that applies the manufacturers truck performance curve data (rimpull and retarding). These simulations were ran over road profiles corresponding to the routes that the 'Appendix D' time studies were done on.

Pages E3 to E8 provide examples of six haul cycle simulations along with a comparison of haul times over the same route based on a time study and obtained from OBDAS data.

SIMULATION DATA:

EUC R-170E TRUCK HAULING HARD ROCK FROM 8703171 TO

SEGMENT DISTANCE Metres	ROAD GRADE Percent	ROLLING RESISTANCE Percent	VELOCITY LIMIT Kph	ENTRANCE VELOCITY Kph	EXIT VELOCITY Kph	SEGMENT TIME Seconds	CUMULATIVE DISTANCE Metres	CUMULATIVE TIME Seconds
163.86	1.04	4.00	27.00	0.00	27.00	26.25	163.86	26.25
260.30	8.30	4.00	27.00	27.00	12.67	68.41	424.16	94.66
139.98	6.57	4.00	27.00	12.67	15.25	33.81	564.14	128.47
200.35	6.74	4.00	27.00	15.25	14.99	48.05	764.49	176.52
115.86	7.94	4.00	27.00	14.99	13.10	31.31	880.36	207.83
236.81	6.12	4.00	27.00	13.10	16.04	54.01	1117.17	261.84
164.72	3.34	4.00	20.00	16.04	0.00	33.92	1281.89	295.76

* TOTAL VARIABLE HAUL TIME LOADED: 4.93 Minutes *

SEGMENT DISTANCE Metres	ROAD GRADE Percent	ROLLING RESISTANCE Percent	VELOCITY LIMIT Kph	ENTRANCE VELOCITY Kph	EXIT VELOCITY Kph	SEGMENT TIME Seconds	CUMULATIVE DISTANCE Metres	CUMULATIVE TIME Seconds
164.72	-3.34	4.00	20.00	0.00	19.28	30.50	164.72	30.50
236.81	-6.12	4.00	27.00	19.28	27.00	31.73	401.53	62.24
115.86	-7.94	4.00	27.00	27.00	27.00	15.44	517.39	77.68
200.35	-6.74	4.00	27.00	27.00	27.00	26.71	717.75	104.39
139.98	-6.57	4.00	27.00	27.00	27.00	18.69	857.72	123.08
260.30	-8.30	4.00	27.00	27.00	27.00	34.73	1118.02	157.81
163.86	-1.04	4.00	27.00	27.00	0.00	26.40	1281.89	184.21

* TOTAL VARIABLE HAUL TIME EMPTY: 3.07 Minutes *

** TOTAL HAUL TIME LOADED AND RETURN: 8.00 Minutes **

E3

Refer to page D2, file 8703171

	Haul Time Loaded	Haul Time Empty	Total
Simulation	4.93	3.07	8.00
Haul Study	4.82	2.88	7.70
OBDAS	4.75	3.92	8.67

SIMULATION DATA:

EUC R-170E TRUCK HAULING HARD ROCK FROM 8704011 TO

SEGMENT DISTANCE Metres	ROAD GRADE Percent	ROLLING RESISTANCE Percent	VELOCITY LIMIT Kph	ENTRANCE VELOCITY Kph	EXIT VELOCITY Kph	SEGMENT TIME Seconds	CUMULATIVE DISTANCE Metres	CUMULATIVE TIME Seconds
281.01	0.46	4.00	27.00	0.00	27.00	41.39	281.01	41.39
116.81	6.16	4.00	27.00	27.00	16.16	22.20	397.82	63.58
197.68	4.60	4.00	27.00	16.16	19.09	38.15	595.50	101.73
275.67	6.13	4.00	27.00	19.09	16.06	60.85	871.17	162.58
147.00	6.05	4.00	27.00	16.06	16.16	32.77	1018.17	195.35
162.75	-0.18	4.00	27.00	16.16	27.00	23.13	1180.91	218.49
81.48	9.82	4.00	27.00	27.00	10.89	20.56	1262.40	239.05
219.80	8.96	4.00	27.00	10.89	11.86	66.98	1482.20	306.02
271.23	6.53	4.00	27.00	11.86	15.33	64.68	1753.43	370.71
228.97	0.22	4.00	16.00	15.33	0.00	55.76	1982.41	426.46

* TOTAL VARIABLE HAUL TIME LOADED: 7.11 Minutes *

SEGMENT DISTANCE Metres	ROAD GRADE Percent	ROLLING RESISTANCE Percent	VELOCITY LIMIT Kph	ENTRANCE VELOCITY Kph	EXIT VELOCITY Kph	SEGMENT TIME Seconds	CUMULATIVE DISTANCE Metres	CUMULATIVE TIME Seconds
228.97	-0.22	4.00	16.00	0.00	16.00	52.17	228.97	52.17
271.23	-6.53	4.00	27.00	16.00	27.00	36.38	500.21	88.55
219.80	-8.96	4.00	27.00	27.00	27.00	29.36	720.01	117.92
81.48	-9.82	4.00	27.00	27.00	27.00	10.86	801.50	128.77
162.75	0.18	4.00	27.00	27.00	27.00	21.71	964.24	150.48
147.00	-6.05	4.00	27.00	27.00	27.00	19.66	1111.24	170.14
275.67	-6.13	4.00	27.00	27.00	27.00	36.80	1386.91	206.94
197.68	-4.60	4.00	27.00	27.00	27.00	26.37	1584.59	233.32
116.81	-6.16	4.00	27.00	27.00	27.00	15.60	1701.40	248.92
281.01	-0.46	4.00	27.00	27.00	0.00	42.22	1982.41	291.14

* TOTAL VARIABLE HAUL TIME EMPTY: 4.85 Minutes *

** TOTAL HAUL TIME LOADED AND RETURN: 11.96 Minutes **

Refer to page D4, file 8704011

	Haul Time Loaded	Haul Time Full	Total
Simulation	7.11	4.85	11.96
Haul Study	6.52	3.97	10.49
OBDAS	6.45	4.08	10.53

SIMULATION DATA:

EUC R-170E TRUCK HAULING TOPSOIL FROM 8704021 TO

SEGMENT DISTANCE Metres	ROAD GRADE Percent	ROLLING RESISTANCE Percent	VELOCITY LIMIT Kph	ENTRANCE VELOCITY Kph	EXIT VELOCITY Kph	SEGMENT TIME Seconds	CUMULATIVE DISTANCE Metres	CUMULATIVE TIME Seconds
236.50	0.55	4.00	27.00	0.00	27.00	34.91	236.50	34.91
116.81	6.16	4.00	27.00	27.00	17.79	20.77	353.32	55.68
197.68	4.60	4.00	27.00	17.79	20.64	35.24	551.00	90.92
275.67	6.13	4.00	27.00	20.64	17.62	55.41	826.66	146.34
147.00	6.05	4.00	27.00	17.62	17.72	29.88	973.66	176.22
87.17	3.10	4.00	27.00	17.72	23.67	14.47	1060.84	190.68
207.06	6.23	4.00	18.00	23.67	17.38	42.94	1267.90	233.63

* TOTAL VARIABLE HAUL TIME LOADED: 3.89 Minutes *

SEGMENT DISTANCE Metres	ROAD GRADE Percent	ROLLING RESISTANCE Percent	VELOCITY LIMIT Kph	ENTRANCE VELOCITY Kph	EXIT VELOCITY Kph	SEGMENT TIME Seconds	CUMULATIVE DISTANCE Metres	CUMULATIVE TIME Seconds
207.06	-6.23	4.00	18.00	0.00	18.00	41.84	207.06	41.84
87.17	-3.10	4.00	27.00	18.00	27.00	11.98	294.23	53.82
147.00	-6.05	4.00	27.00	27.00	27.00	19.66	441.23	73.48
275.67	-6.13	4.00	27.00	27.00	27.00	36.80	716.90	110.28
197.68	-4.60	4.00	27.00	27.00	27.00	26.37	914.58	136.65
116.81	-6.16	4.00	27.00	27.00	27.00	15.60	1031.40	152.25
236.50	-0.55	4.00	27.00	27.00	0.00	36.25	1267.90	188.50

* TOTAL VARIABLE HAUL TIME EMPTY: 3.14 Minutes *

** TOTAL HAUL TIME LOADED AND RETURN: 7.04 Minutes **

Refer to page D4, file 8704021

	Haul Time Loaded	Haul Time Full	Total
Simulation	3.89	3.14	7.04
Haul Study	4.67	3.32	7.99
OBDAS	4.68	3.28	7.96

SIMULATION DATA:

EUC R-170E TRUCK HAULING TOPSOIL FROM 8704022 TO

SEGMENT DISTANCE Metres	ROAD GRADE Percent	ROLLING RESISTANCE Percent	VELOCITY LIMIT Kph	ENTRANCE VELOCITY Kph	EXIT VELOCITY Kph	SEGMENT TIME Seconds	CUMULATIVE DISTANCE Metres	CUMULATIVE TIME Seconds
236.50	0.55	4.00	27.00	0.00	27.00	34.91	236.50	34.91
116.81	6.16	4.00	27.00	27.00	17.79	20.77	353.32	55.68
197.68	4.60	4.00	27.00	17.79	20.64	35.24	551.00	90.92
275.67	6.13	4.00	27.00	20.64	17.62	55.41	826.66	146.34
147.00	6.05	4.00	27.00	17.62	17.72	29.88	973.66	176.22
162.75	-0.18	4.00	27.00	17.72	27.00	22.66	1136.41	198.87
81.48	9.82	4.00	27.00	27.00	12.25	18.80	1217.89	217.67
219.80	8.96	4.00	27.00	12.25	13.12	60.50	1437.70	278.17
78.30	7.92	4.00	27.00	13.12	0.00	22.04	1516.00	300.21

* TOTAL VARIABLE HAUL TIME LOADED: 5.00 Minutes *

SEGMENT DISTANCE Metres	ROAD GRADE Percent	ROLLING RESISTANCE Percent	VELOCITY LIMIT Kph	ENTRANCE VELOCITY Kph	EXIT VELOCITY Kph	SEGMENT TIME Seconds	CUMULATIVE DISTANCE Metres	CUMULATIVE TIME Seconds
78.30	-7.92	4.00	27.00	0.00	27.00	11.18	78.30	11.18
219.80	-8.96	4.00	27.00	27.00	27.00	29.36	298.10	40.54
81.48	-9.82	4.00	27.00	27.00	27.00	10.86	379.59	51.40
162.75	0.18	4.00	27.00	27.00	27.00	21.71	542.33	73.11
147.00	-6.05	4.00	27.00	27.00	27.00	19.66	689.33	92.77
275.67	-6.13	4.00	27.00	27.00	27.00	36.80	965.00	129.57
197.68	-4.60	4.00	27.00	27.00	27.00	26.37	1162.68	155.94
116.81	-6.16	4.00	27.00	27.00	27.00	15.60	1279.49	171.54
236.50	-0.55	4.00	27.00	27.00	0.00	36.25	1516.00	207.79

* TOTAL VARIABLE HAUL TIME EMPTY: 3.46 Minutes *

** TOTAL HAUL TIME LOADED AND RETURN: 8.47 Minutes **

Refer to page D5, file 8704022

	Haul Time Loaded	Haul Time Full	Total
Simulation	5.00	3.46	8.47
Haul Study	6.07	3.65	9.72
OBDAS	5.97	3.67	9.64

SIMULATION DATA:

EUC R-170E TRUCK HAULING HARD ROCK FROM 8704031 TO

SEGMENT DISTANCE Metres	ROAD GRADE Percent	ROLLING RESISTANCE Percent	VELOCITY LIMIT Kph	ENTRANCE VELOCITY Kph	EXIT VELOCITY Kph	SEGMENT TIME Seconds	CUMULATIVE DISTANCE Metres	CUMULATIVE TIME Seconds
306.64	-2.09	4.00	27.00	0.00	27.00	43.57	306.64	43.57
275.67	6.13	4.00	27.00	27.00	16.06	57.70	582.31	101.27
147.00	6.05	4.00	27.00	16.06	16.16	32.77	729.31	134.04
87.17	3.10	4.00	27.00	16.16	22.10	15.54	816.48	149.58
226.97	6.12	4.00	18.00	22.10	16.07	50.45	1043.46	200.03

* TOTAL VARIABLE HAUL TIME LOADED: 3.33 Minutes *

SEGMENT DISTANCE Metres	ROAD GRADE Percent	ROLLING RESISTANCE Percent	VELOCITY LIMIT Kph	ENTRANCE VELOCITY Kph	EXIT VELOCITY Kph	SEGMENT TIME Seconds	CUMULATIVE DISTANCE Metres	CUMULATIVE TIME Seconds
226.97	-6.12	4.00	18.00	0.00	18.00	45.81	226.97	45.81
87.17	-3.10	4.00	27.00	18.00	27.00	11.98	314.15	57.79
147.00	-6.05	4.00	27.00	27.00	27.00	19.66	461.15	77.45
275.67	-6.13	4.00	27.00	27.00	27.00	36.80	736.81	114.25
306.64	2.09	4.00	27.00	27.00	0.00	45.85	1043.46	160.10

* TOTAL VARIABLE HAUL TIME EMPTY: 2.67 Minutes *

** TOTAL HAUL TIME LOADED AND RETURN: 6.00 Minutes **

Refer to page D5, file 8704031

	Haul time Loaded	Haul Time Full	Total
Simulation	3.33	2.67	6.00
Haul Study	4.22	3.02	7.24
OBDAS	4.13	3.27	7.40

SIMULATION DATA:

EUC R-170E TRUCK HAULING HARD ROCK FROM 8704091 TO

SEGMENT DISTANCE Metres	ROAD GRADE Percent	ROLLING RESISTANCE Percent	VELOCITY LIMIT Kph	ENTRANCE VELOCITY Kph	EXIT VELOCITY Kph	SEGMENT TIME Seconds	CUMULATIVE DISTANCE Metres	CUMULATIVE TIME Seconds
224.99	7.78	4.00	27.00	0.00	13.28	63.16	224.99	63.16
197.68	4.60	4.00	27.00	13.28	19.09	38.95	422.67	102.11
275.67	6.13	4.00	27.00	19.09	16.06	60.85	698.34	162.96
147.00	6.05	4.00	27.00	16.06	16.16	32.77	845.34	195.73
162.75	-0.18	4.00	27.00	16.16	27.00	23.13	1008.09	218.86
81.48	9.82	4.00	27.00	27.00	10.89	20.56	1089.57	239.42
219.80	8.96	4.00	27.00	10.89	11.86	66.98	1309.37	306.40
197.77	6.98	4.00	27.00	11.86	14.54	49.74	1507.15	356.13
109.09	3.12	4.00	16.00	14.54	0.00	28.21	1616.24	384.34

* TOTAL VARIABLE HAUL TIME LOADED: 6.41 Minutes *

SEGMENT DISTANCE Metres	ROAD GRADE Percent	ROLLING RESISTANCE Percent	VELOCITY LIMIT Kph	ENTRANCE VELOCITY Kph	EXIT VELOCITY Kph	SEGMENT TIME Seconds	CUMULATIVE DISTANCE Metres	CUMULATIVE TIME Seconds
109.09	-3.12	4.00	16.00	0.00	16.00	25.01	109.09	25.01
197.77	-6.98	4.00	27.00	16.00	27.00	26.66	306.87	51.67
219.80	-8.96	4.00	27.00	27.00	27.00	29.36	526.67	81.03
81.48	-9.82	4.00	27.00	27.00	27.00	10.86	608.15	91.89
162.75	0.18	4.00	27.00	27.00	27.00	21.71	770.90	113.60
147.00	-6.05	4.00	27.00	27.00	27.00	19.66	917.90	133.26
275.67	-6.13	4.00	27.00	27.00	27.00	36.80	1193.57	170.06
197.68	-4.60	4.00	27.00	27.00	27.00	26.37	1391.24	196.43
224.99	-7.78	4.00	27.00	27.00	0.00	34.26	1616.24	230.70

* TOTAL VARIABLE HAUL TIME EMPTY: 3.84 Minutes *

** TOTAL HAUL TIME LOADED AND RETURN: 10.25 Minutes **

Refer to page D6, file 8704091

	Haul Time Loaded	Haul Time Full	Total
Simulation	6.41	3.84	10.25
Haul Study	6.77	3.57	10.34
OBDAS	6.77	3.95	10.72

APPENDIX F

Assessment of Mechanical Downtime

The following table summarizes the mechanical availability of the two haul trucks (6126 and 6127) having OBDAS in comparison to the fleet (eight haul trucks including 6126 and 6127) mechanical availability over the year (1987).

	6126	6127	Fleet
January	73.4	79.7	85.4
February	85.7	84.1	85.5
March	78.8	70.0	82.5
April	97.7	91.7	80.2
May	idle		
June	87.6	88.9	86.4
July	93.0	89.0	84.1
August	87.4	83.2	84.2
September	81.5	91.5	83.3
October	92.6	91.5	86.7
November	93.8	82.5	87.4
December	91.4	89.9	86.5
TOTAL	86.8	85.2	84.8

As indicated in this table the initial installation of OBDAS components in January and repairs to the load sensors in March did effect the mechanical availability of these two trucks; representing approximately 230 hours of lost production time.

Outside of these two months the mechanical availability on the OBDAS equipped trucks were at or above the fleet average.

APPENDIX G

Assessment of Operator Acceptance

Because the objective of installing an on-board data collection and vehicle management system is to improve productivity from a piece of equipment, the operator on that equipment must accept the system. This acceptance is gained through an understanding of this objective and on how the system operates, a willingness to provide the required operator input needed and assurance in the on-board output that is provided to him.

During installation of the system in January a series of orientation discussions were held with the truck drivers and pit supervisors to outline the purpose of the demonstration and evaluation project and to describe the OBDAS components, how they work and what it will provide to the operation. By holding these meetings at the start of the project and allowing operator input to the placement of system components, proved valuable in gaining operator acceptance.

The input coding from the operator to OBDAS's processor was designed using coding already used by and thus familiar to the operators. This, combined with the ease and speed of entering codes into the processor easily achieved this aspect of operator acceptance.

Confidence that the system is providing accurate information is the most important area to consider when weighing overall operator acceptance. Because the only system output relayed to the truck driver is payload, as provided by the load sensors, his judgement will be based on the confidence he can place on the accuracy of this number. During the course of the evaluation the problems associated with the load sensors were reflected by a drop in operator acceptance. This drop in acceptance was also notable in maintenance and supervisory personnel. To regain acceptance in the system, it is felt that it will have to prove mechanically reliable over a four-to-six period with periodic weigh studies to verify the load sensor output.

APPENDIX H

Overview of Problems Associated with the Evaluation

Jan. 5 to 9	- install OBDAS components on unit #6126 - modify base plate bolting positions
Jan. 10 to 14	- install OBDAS components on unit #6127 - faulty proximity switch
Jan. 20	- 1/4" dia. nylon tubing (from load sensor to pressure transducer) kinked on 6126, replaced
Jan. 28	- mounting lugs: floating cap channel to base plate assembly, broken 6127, repaired and gusseted for additional strength
Jan. 29	- first indication on oil leaking from load sensor termination clamp on 6126, Philippi-Hagenbuch to remanufacture clamps using steel (vs. aluminum)
Feb. 16	- load sensors of 6127 leaking oil, also discovered that load sensor hoses are being cut by the contact plate
March 7 - 10	- replace load sensors, hoses and clamps on 6127
March 11 - 14	- replace load sensors on 6126
March 30	- dump switch on 6126 replaced
March	- new software developed for both the OBDAS processors and host computer to allow the re-transmission of erroneous data as detected by a checksum
April	- load sensor hoses leaking oil at both termination and transducer clamps. Testing by Philippi-Hagenbuch conclude that the different type of material is required in the hose. Manufacturing and testing of new hoses delay replacement until late August
August 28 - 30	- load sensor hoses replaced on both units